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OAL MEMORANDUM 85

CALCULATION OF THE FLOW FIELDS AROUND A SERIES OF BI-CONIC BODIES OF REVOLUTION USING THE METHOD OF CHARACTERISTICS AS APPLIED TO SUPERSONIC ROTATIONAL FLOW

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CALCULATION OF THE FLOW FIELDS AROUND A SERIES OF BI-CONIC BODIES OF REVOLUTION USING THE METHOD OF CHARACTERISTICS AS APPLIED TO SUPERSONIC ROTATIONAL FLOW

SUMMARY

The flow fields around a series of bi-conic bodies of revolution placed in a supersonic air stream were analyzed using the Method of Characteristics as applied to rotational flow. Calculations were carried out for three different cone combinations (25° - 40°, 20° - 40°, 25° - 35°) associated with various free stream Mach numbers. The results were used in designing a diffuser inlet.

A study was made of the overall effects produced by rounding-off errors, varying the size of the mesh, and disregarding the entropy term. Some interesting tables and graphs are included.

It is thought that these results will be of interest to engineers engaged in aerodynamic research and development.

INTRODUCTION

Recently the Applied Mathematics section of the Ordnance Aerophysics Laboratory calculated the flow fields about a series of twelve bi-conic bodies of revolution (hereafter referred to as "double-cones") placed in a supersonic air stream. The necessity for such computations arose in connection with the axisymmetric supersonic inlet design effort at the Applied Physics Laboratory, The Johns Hopkins University. This memorandum presents the results of the

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above calculations, along with a few comments and observations.

The problem was first programmed for the IBM Card Program Calculator and later put on the powerful 650, on which machine the twelve flow fields were determined. All calculations were carried out on an eight place floating decimal board and the tabulated results are thought to be free of calculational errors. Use was made of various polynominal approximations in one and two variables.

All information concerning conical flow was obtained from reference (1), where the specific heat ratio was taken as 1.405. In all other calculations $\gamma = 1.4$ was used. This discrepancy affects M_o but slightly. Such unusual values of the free stream Mach numbers as 2.3604, etc., were chosen in order to be able to use the tables of reference (1).

The purpose of this publication is twofold: (1) to outline a method for calculating the flow fields around double-cones using ordinary IBM equipment and (2) to present and discuss some of the results obtained.

NOMENCLATURE

a	local velocity of sound
d	length of a side of a mesh
g	acceleration due to gravity: 32.174 ft/sec^2
M	Mach number back of the curved shock (region III)
M_o	Mach number in the conical flow field (region II)
M_o'	Mach number in the free stream (region I)
M^*	defined by equation (7)
P	end-point of shock front

R	universal gas constant: 53.345 ft/°F.
r	distance from mid-point of a runner to cone axis
S	entropy
S^*	$\Delta S/\gamma Rg$
u	radial velocity component in region II.
v	tangential velocity component in region II.
x, y	rectangular coordinates
α	Mach angle = arc sin (1/M)
β_1, β_2	generating angle of first, second cone
γ	specific heat ratio
δ	associated wedge angle; deflection angle
θ	inclination of flow back of curved shock (region III)
θ_w	shock wave angle associated with curved shock
λ	ray angle in the conical flow field (region II)
ϕ	inclination of flow in the conical field (region II)

SUBSCRIPTS

R	designates right-running characteristic line
L	designates left-running characteristic line
s	refers to surface solution
3	refers to the point to be calculated
n	refers to normal component, as M_n

SUPERSCRIPTS

* on a number refers to an interpolated point

THE PROBLEM

Figure 1 shows a cross-section of the upper half of a 25° - 40° double cone placed in a supersonic air stream at zero angle of attack. The flow in region I (free stream region) is supersonic and irrotational. Immediately back of the conical shock (which is a straight line) the flow is still supersonic and irrotational (isentropic). When this supersonic stream strikes the second cone a curved shock front OP is produced, back of which the flow is rotational (non-isentropic). This second shock is curved due to the fact that the Mach number is not constant in region II. This causes an entropy gradient between streamlines in region III, which means that the flow is rotational there. The dotted line lying in the plane of the paper is a typical streamline.

The problem is to analyze the flow field in region III using the Method of Characteristics. In particular, we wish to find the Mach number and flow direction at a series of grid points covering that region.

The twelve flow fields analyzed are listed below:

Group	A (25° - 40°)	B (20° - 40°)	C (25° - 35°)
Mach Number M_o'	2.3604	2.4431	2.0665
	2.7296	2.8387	2.3604
	3.2188	3.3694	2.7296
	3.9260	4.1538	3.2188

For the sake of brevity these combinations will be referred to as A(2.7296), B(4.1538), etc., meaning the second Mach number in group A, the fourth in group B, etc.

MATHEMATICAL ANALYSIS AND FORMULAS

A. REGION II.

In reference 1 the conical flow parameters, λ , a^2, u, and v are tabulated at equal intervals of the ray angle for various combinations of the cone angle and free stream Mach number. Using these values the Mach number and flow inclination at any point in the conical regime may be obtained from

(1) $$M_o^2 = (u^2 + v^2)/a^2$$

(2) $$\phi = \lambda + \arctan (v/u)$$

In using these tables care should be taken to avoid the numerous errors therein.

Accurate fifth degree Gram-Tshebysheff polynominal approximations were obtained for M_o and ϕ in terms of λ . These are listed under the various combinations. The method used in developing these polynominal approximations is illustrated in Table VI, where M_o is found in terms of a fifth-degree polynominal in λ . The eleven values of M_o listed under $\phi(x)$ were taken from reference 1.

It should be recalled that in conical flow all parameters are constant along a ray emanating from the cone apex. The streamlines are curved and approach the cone surface asymptotically on an infinite cone. In all cases the radius of the base of the first cone was taken as 10.

B. REGION III.

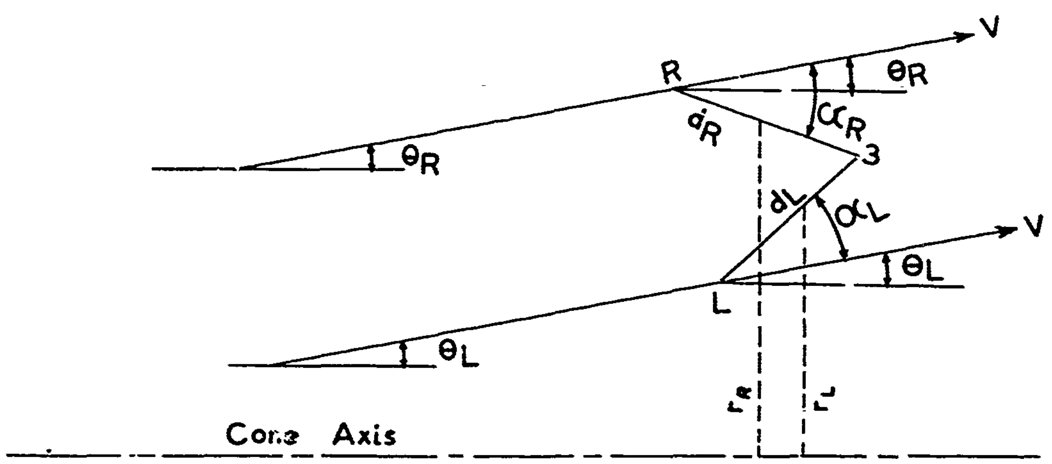
The flow parameters in this region are described by a set of complicated transcendental equations which cannot be solved in closed form, but which can be approximated stepwise by the Method of Characteristics. Since the method itself is well known only a brief outline of the steps involved will be given. It is assumed that the reader is familiar with the general terminology employed. The computational work divides itself into three distinct types: (1) Network, (2) Surface, and (3) Shock Solutions.

I. Network Solution

The sketch below illustrates the parameters involved in a general network solution. The points R and L represent two diagonal points of the network at which all parameters are known. The point 3 is determined by the intersection of the right-running characteristic line through R (R3) and the left-running characteristic through L (L3). The slopes of these two lines are given, respectively, by

(3) $$m_R = \tan(\theta_R - \alpha_R)$$

(4) $$m_L = \tan(\theta_L + \alpha_L)$$



From reference (2), p. 279, it may be shown that the equation of the right and left runners are given by

$$(5) \qquad \theta_R - \theta_3 = \left[\frac{M_3^*}{M_R^*} - 1 \right] \cot \alpha_R - (\sin\theta \sin\alpha \; d/r)_R - \frac{(S_R - S_L)}{\gamma \, Rg} \cdot \frac{(\sin^2\alpha \cos\alpha \;\; d)_R}{d_L \sin\alpha_L + d_R \sin\alpha_R}$$

and

$$(6) \qquad \theta_3 - \theta_L = \left[\frac{M_3^*}{M_L^*} - 1 \right] \cot \alpha_L - (\sin\theta \sin\alpha \; d/r)_L + \frac{(S_R - S_L)}{\gamma \, Rg} \cdot \frac{(\sin^2\alpha \cos\alpha \;\; d)_L}{d_L \sin\alpha_L + d_R \sin\alpha_R}$$

respectively, where

$$(7) \qquad M^{*2} = \frac{\frac{\gamma + 1}{2} \; M^2}{1 + \frac{\gamma - 1}{2} \; M^2}$$

and θ is in radians.

The simultaneous solution of (5) and (6) yields

$$(8) \qquad M_3^* = \left[\theta_R - \theta_L + \cot\alpha_L + \cot\alpha_R + (\sin\alpha \sin\theta \; d/r)_L + (\sin\alpha \sin\theta \; d/r)_R - \frac{(S_R - S_L)}{\gamma \, Rg} \cdot \frac{(\sin^2\alpha \cos\alpha \;\; d)_L - (\sin^2\alpha \cos\alpha \;\; d)_R}{d_L \sin\alpha_L + d_R \sin\alpha_R} \right] \left[\left(\frac{\cot\alpha}{M^*} \right)_L + \left(\frac{\cot\alpha}{M^*} \right)_R \right]^{-1}$$

The above value of M_3^* is substituted in (6) and (7), thereby yielding the Mach number and flow inclination at the point 3.

The parameters at interpolated points (starred points) are obtained by straight-line interpolation and need no further explanation.

Figure 3 further illustrates the situation at a net point.

II. Surface Solutions.

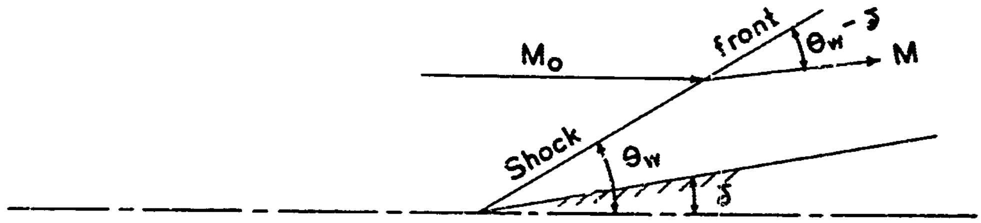
If point 3 is on the cone surface then θ_3 is known, being equal to the generating angle of the second cone. Hence from (5) it follows that

$$(9) \qquad M_{3s}^* = M_R^* + M_R^* \tan \alpha_R \left[\theta_R - \theta_{3s} + (\sin \alpha \sin \theta \quad d/r)_R + \frac{(S_R - S_L)}{\gamma\, Rg} \quad (\sin \alpha_R \cos \alpha_R) \right],$$

where S_L has the value of entropy in the surface streamline. See p. 280 of reference (2).

III. Shock Solutions

The flow parameters immediately back of the curved shock may be found by solving simultaneously the oblique shock equations of wedge flow and the left-running characteristic equation. This means that the flow inclination, shock wave angle, and the Mach number behind the shock must agree with the flow angle and Mach number given by equation (6). The sketch below illustrates wedge flow.



From reference (2) the oblique shock equations are

(10) $$\cot \delta = \left[\frac{\gamma + 1}{2} \cdot \frac{M_o^2}{M_o^2 \sin^2\theta_w - 1} - 1 \right] \tan \theta_w$$ and

(11) $$\left[M_o^2 \sin^2\theta_w - (\gamma - 1)/2\gamma \right]\left[M^2 \sin^2 (\theta_w - \delta) - (\gamma - 1)/2\gamma \right] = \left(\frac{\gamma + 1}{2\gamma}\right)^2$$

The left-runner may be written in the form

(12) $$\theta_3 = \left[\frac{\cot \alpha_L}{M_L^*} \right] M_3^* - \cot \alpha_L + \theta_L - (\sin \alpha \sin \theta \, d/r)_L + \frac{(S_3 - S_L)}{\gamma R g} \sin \alpha_L \cos \alpha_L.$$

Note that this last equation is linear in θ_3 and M_3^*. The next step is to solve simultaneously (10), (11), (12), and (7). This generally involves a good deal of computational work.

To illustrate the method of finding a shock solution let us refer to

Figure 4. Assume all parameters known at the shock point 8 and at the interpolated point 8^*. To find the solution at 9 proceed as follows:

a. Assume θ_w and $\Delta S/Rg$ at the point 9 to be equal to the values at the preceding point, 8. That is, assume $\theta_{w9} = \theta_{w8}$ as a first approximation.

b. The equation of the line (7-8) and the equation of the left-runner at 8^* are solved simultaneously, obtaining a point 9' which is the first approximation to 9.

c. Now knowing the coordinates of 9' the ray angle, $\lambda_{9'}$, is obtained. This value of λ substituted in the fifth-degree polynominal approximation yields M_o and ϕ.

d. Next eliminate M_3^* between (12) and the two-way approximation for M_3^*, noting that $\delta + \phi = \theta$. This results in a quadratic equation in δ which is readily solved.

e. Then knowing M and δ the first iterated value of $\Delta S/Rg$ $\left[\text{say, } (\Delta S/Rg)_{9*} \right]$ is obtained from the two-way approximation. Follow procedure a-d to get δ_{9*}, the first iterated value of δ, from which another value of $\Delta S/Rg$ is obtained.

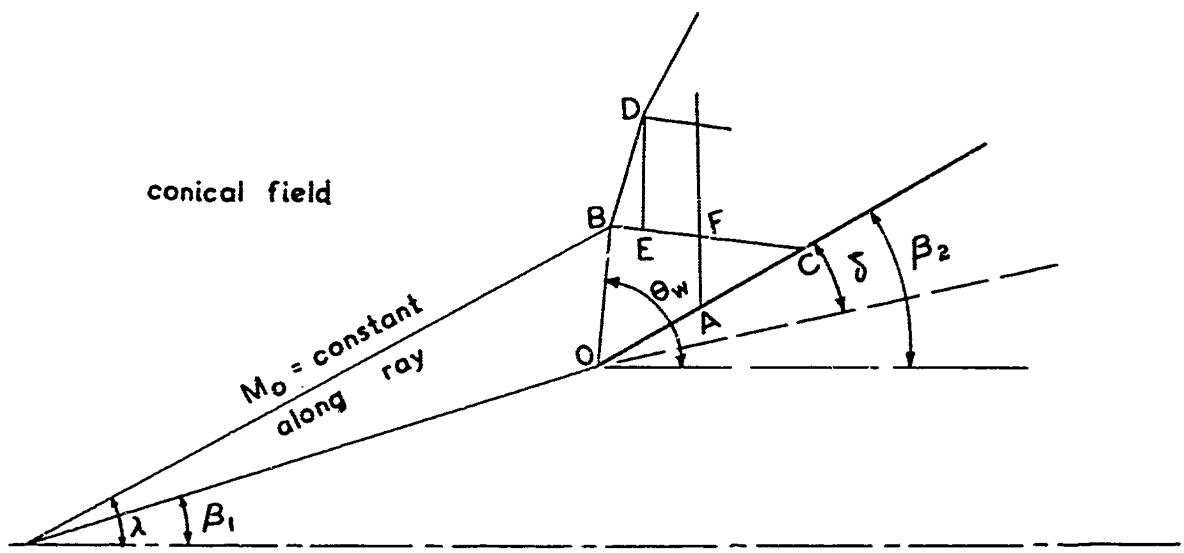
f. $\theta_w - \phi$ is now calculated from the approximating polynominal. This gives the first iterated value of θ_w, say θ_{w9*}.

g. Now repeat the entire procedure, going through three more iterations. In this manner the parameters at the shock point 9 are obtained. Fortunately, the iterative process converges rapidly in all cases.

IV. Starting Solution

A point A is chosen on the surface of the second cone fairly close to O. Knowing λ on the first cone surface the Mach number M_o is found from the

fifth-degree approximation and the parameters at A are obtained assuming wedge flow. The entropy term $\Delta S/Rg$ is found from the approximation. Since θ_L is known and α_L readily found, the left-runner from A is drawn in roughly.



Knowing M_o on the cone surface and the deflection angle δ, θ_w is found from reference (3) or (4) and a line is drawn through 0 with an inclination of θ_w. A preliminary point B is taken on this line and, keeping the distance OB constant, θ_w and $\Delta S/Rg$ are obtained from the approximation formulas by iteration. The initial value of entropy at B is taken equal to that at A.

PRELIMINARY WORK

In our case quite a good deal of preliminary work was necessary before the problem could be put on the machine. The parameters at A and B (points 101 and 2 of Figure 2) were obtained by desk calculator and given to the IBM-650

machine which performed all other calculations. A little judgment plus a couple of trials should enable one to obtain a rough value of the coordinates of the starting points graphically. Iteration is then applied at point B in order to get the parameters accurately.

Point E (the starred point, 2^* of Figure 2) is chosen by eye so that the left-runner through it will locate roughly a point D on the shock such that the distance BD is of the desired length. Knowing OB, BD, and λ_{max} it is possible to estimate the number of points on the curved shock front. This gives a measure of the accuracy of the process. The ratio BE/BF, estimated graphically, was given to the machine which then calculated the length BE and made all other base distances (distance from a shock point to the associated starred point) that same length. If the starred point happened to fall close to a mesh-point then the left-runner through the latter was used and the starred point disregarded. This means that sometimes a left-runner starting from the cone surface went all the way to the shock front and sometimes it didn't. The machine was given a criterion for deciding whether or not to establish a starred point. Also, knowing λ_{max} it was able to stop after locating one shock point above this ray. After obtaining the coordinates of the last shock point the machine found the distance from each remaining net point to the perpendicular from the last shock point to the second cone surface, using the distance formula of analytic geometry. At the same time it tested this number for sign. When the sign changed along any given left-runner the machine stopped calculations on that characteristic line and went back to the surface and started up another left-runner. After giving the 650 machine the necessary initial instructions and constants it required no further attention until the problem was finished and ready to list.

In this connection it was necessary to construct an oblique shock table giving $\theta_w - \phi$, M_{no}, M, and M^* in terms of M_o and δ (reference 4). The table was constructed on the 650 and covers a range of $1.00 \leq M_o\ (.01) \leq 3.60$; $0.000 \leq \delta\ (.005) \leq \delta_{max}$. (δ in radians)

DISCUSSION OF THE APPROXIMATION FORMULAS

The approximations used in obtaining M_o and ϕ have already been discussed in some detail. These were relatively easy to get, since most of the computations were carried out on the IBM machine. The formulas are as accurate as the original data.

Much more difficult to develop were the two-way quadratic approximations for $\theta_w - \phi$, $\Delta S/Rg$, and M^* in terms of M_o and δ. These required the use of the oblique shock table mentioned above. Using numerical differentiation and Taylor's Theorem for two variables the quadratic approximations were obtained. The entropy values were taken from reference (5). These approximations give satisfactory results, since, in each case, the independent variables range over only a limited region. The numerical differentiation was carried out on a desk calculator. See reference (6).

A list of approximation formulas for A(2.3604) is given below. The formulas for the other eleven cases are not included, but are available at this facility.

The equations for the terminal point P (Table V) were developed by desk calculator using Lagrange's Formula for unequal intervals. See reference (6).

The twelve shock fronts were approximated by third degree Gram-Tshebysheff polynominals and are shown in Table IV. Using these approximations, curves of

A_1, A_2, and A_3 vs M_o' were plotted (Figures 8, 9, and 10). The coefficients of a third degree approximation for any value of M_o' within the range of interest may be read directly from these graphs. Thus for a 25° - 40° double-cone with $M_o' = 3.5$ the shock front equation is readily found to be

(14) $$x = -.00016 + .489\,y + .01618\,y^2 - .000421\,y^3.$$

This equation gives better results than can be obtained by interpolating linearly between the curves of Figure 5.

LIST OF APPROXIMATION FORMULAS FOR A(2.3604)

$$M_o = 1.66666 + .00149\,x + .12579\,x^2 - .04247\,x^3 - .01486\,x^4 + .03167\,x^5$$

$$\phi = .43633 - .23574\,x + .12085\,x^2 - .10296\,x^3 + .06772\,x^4 - .02909\,x^5$$

where $x = 4.24570\,\lambda - 1.85254$ (λ in radians)

$$\theta_w - \phi = .95394 - .89574\,(M - 1.72) + 2.18448\,(\delta - .260) + 2.1535\,(M - 1.72)^2 - 8.6645\,(M - 1.72)(\delta - .260) + 10.94\,(\delta - .260)^2$$

(δ in radians)

$$M^* = 1.12383 + .99265\,(M - 1.72) - 2.35532\,(\delta - .260) - 1.754\,(M - 1.72)^2 + 8.1335\,(M - 1.72)(\delta - .260) - 11.326\,(\delta - .260)^2$$

(δ in radians)

$$\Delta S/Rg = .04349 - .0195\,(M - 1.72) + .571\,(\delta - .260) + .35\,(M - 1.72)^2 + 1.35\,(M - 1.72)(\delta - .260) + 4.2\,(\delta - .260)^2$$

DISCUSSION OF RESULTS

Values of x, y, M, and θ are tabulated for each grid point. At each shock point M_o and ϕ are also listed. These and many other parameters such as θ_w, α, δ, M^*, and S^* were calculated to eight significant figures and listed for reference, but are not included in this memorandum.

Some useful information was obtained by varying certain parameters or by changing the process. In order to study the effect of entropy several combinations were run assuming irrotational flow in region III. Table III indicates that entropy consideration has little effect on the results -- at least, not for the combinations studied. This is an important piece of information, since it takes about twice as long to calculate a rotational flow field as an irrotational one. Figure 11 shows that the entropy term becomes more important as M_o' increases. However, the rate of increase of the entropy effect becomes less; that is, the error curve flattens out as the Mach number increases. This leads one to speculate on the existence of a maximum error for some large value of M_o'.

Figure 12 illustrates a somewhat surprising fact: namely, the flow deflection (δ) across the second shock front is nearly constant for all cone combinations considered. For small free-stream Mach numbers δ decreases and then increases reaching (approximately) the initial deflection, $\beta_2 - \beta_1$, at the end-point P. For large values of M_o' it seems that δ increases more or less monotonically with x, reaching a maximum at P. The reason for the little

hump near the origin is not known to the writer.

Table II reveals something that was entirely unsuspected -- namely, that rounding off to 5 significant figures (usually 4 decimals) at each step does not cause any appreciable loss of accuracy in the final results. It was also found that certain types of small errors introduced near the beginning (e.g., an error of 1° in the left-runner at 102) have little effect on the parameters at the end-point P. In some cases such errors made at an early stage tend to correct themselves in an asymptotic sort of way as the network expands.

Some statistics on the problem might be of interest. To calculate the parameters at 200 points in a flow field on a CPC machine required 15 hours of machine time. On the 650 machine only an hour and a half was needed. More specifically, it took 1.7 minutes to get a shock point going through 4 iterations, 12 seconds for a net point, 8 for a surface point, and 2 seconds for an interpolated point. To calculate such a flow field by desk calculator would be a formidable task.

It might be pointed out that it is dangerous to attempt to draw general conclusion from a single case. For example, in the case of A(2.3604) Mach number increases as the point moves up the second cone surface while for combination A(3.9260) it decreases.

COMMENTS

Assuming the method itself to be valid the main sources of error in the results are probably due to: (1) different values of γ used in regions II and III (2) relatively large values of mesh lengths and the assumption of linearity and (3) lack of accuracy of the approximation formulas.

It would be difficult to estimate accurately the effect of item (1). From reference (1) it appears that a variation of .005 in γ produces a change of about .01 to .02 in M_o. Fortunately this error in M_o on the shock front is not magnified farther out in the field. So it would seem that this source of error is comparatively unimportant.

Table II shows that the effect of the mesh size is unimportant within limits. Thus a grid of 15 shock points is nearly as good as one of 28 such points for the combination A(3.9260). This is a worthwhile piece of information.

It is believed that the approximations used give good results throughout the field. The formulas for M_o and ϕ are as accurate as the data warrant. Since δ and M_o range over very restricted values it is safe to assume that the two-way approximations are entirely satisfactory.

A detailed worksheet for the problem is not included since anyone interested in carrying out such computations would doubtless prefer to set up his own worksheet.

ACKNOWLEDGMENTS

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REFERENCES

1. Supersonic Flow of Air Around Cones: MIT Technical Report No. 1, 1947.

2. Ferri, Antonio: Elements of Aerodynamics of Supersonic Flows. The MacMillan Company, 1949.

3. Handbook of Supersonic Aerodynamics: NavOrd Report 1488(Vol.2), 1950. Supt. of Documents, Washington 25, D. C.

4. Oblique Shock Tables: Unpublished Manuscript, Ordnance Aerophysics Laboratory, Daingerfield, Texas.

5. Mach Number Tables: Memorandum 10, CF-850. Ordnance Aerophysics Laboratory, Daingerfield, Texas, 1948.

6. Scarborough, James B.: Numerical Mathematical Analysis. Oxford University Press, 1950.

7. Hastings, Cecil, Jr.: Approximations for Digital Computers, The Rand Corporation, Santa Monica, California, 1955.

TABLE I

NUMBER OF POINTS IN FLOW FIELDS AND VALUES OF THE PARAMETERS AT END-POINTS

Combination	Number of Points in the Flow Fields				Parameters at End-Point P			
	Shock	Surface	Network	Total	x	y	M	θ^o
A(2.3604)	19	14	75	108	2.779	9.265	1.203	29.84
A(2.7296)	21	14	97	132	3.429	7.988	1.408	31.92
A(3.2188)	22	14	109	145	3.485	6.595	1.634	33.63
A(3.9260)	28	18	196	242	3.228	5.261	1.895	35.12
B(2.4431)	21	16	90	127	4.246	10.635	1.234	30.33
B(2.8387)	25	18	143	186	4.546	8.813	1.442	32.51
B(3.3694)	25	17	155	197	4.271	7.008	1.677	34.30
B(4.1538)	21	14	96	131	3.693	5.336	1.956	35.84
C(2.0665)	14	11	44	69	4.193	12.798	1.215	23.13
C(2.3604)	19	13	90	122	5.181	11.175	1.402	25.14
C(2.7296)	16	10	62	88	5.370	9.392	1.607	26.90
C(3.2188)	15	10	52	77	5.097	7.669	1.842	28.49

TABLE II

COMPARISON OF RESULTS AT END-POINT P FOR VARIOUS RUNS

(25° - 40° DOUBLE-CONE, $M_o' = 3.9260$)

Run	Description of Run	x	y	M	θ^o	Error in M	Error in θ
1	Rotational. 28 shock points. 8 significant figures carried throughout the calculations.	3.2285	5.2607	1.8953	35.117		
2	Same as (1) except only 15 shock points.	3.2450	5.2709	1.8945	35.136	.0008	-.019
3	Same as (1) except 5 significant figures carried throughout the calculations.	3.2286	5.2608	1.8951	35.122	.0002	-.005

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TABLE III

COMPARISON OF RESULTS AT VARIOUS POINTS FOR DIFFERENT TYPES OF FLOW AROUND A 25° - 40° DOUBLE-CONE

End-Point

Point	Flow	M_o'	x	y	M	$\theta°$	$M_r - M_i$	$\theta_r - \theta_i$
End Point P	Irrotational	2.3604	2.7737	9.2610	1.2050	29.791		
	Rotational	•	2.7789	9.2652	1.2027	29.839	-.0023	.048
	Irrotational	3.2188	3.4988	6.6047	1.6386	33.518		
	Rotational	•	3.4850	6.5955	1.6336	33.633	-.0050	.115
	Irrotational	3.9260	3.2411	5.2685	1.9017	34.975		
	Rotational	•	3.2285	5.2607	1.8953	35.117	-.0064	.142
			Surface Points					
303	Irrotational	2.3604	1.3280	1.1143	1.1072	40.000		
	Rotational	•	•	•	1.1051	40.000	-.0021	0
1313	Irrotational	•	5.5643	4.6690	1.1500	40.000		
	Rotational	•	•	•	1.1449	40.000	-.0051	0
303	Irrotational	3.9260	.9358	.[illegible]852	1.8854	40.000		
	Rotational	•	•	•	1.8870	40.000	.0016	0
1616	Irrotational	•	4.0380	3.3883	1.8780	40.000		
	Rotational	•	•	•	1.8832	40.000	.0052	0
			Net Points					
305	Irrotational	2.3604	1.0779	2.1493	1.1188	37.236		
	Rotational	•	•	•	1.1181	37.220	-.0007	-.016
1115	Irrotational	•	4.1697	6.4690	1.1542	34.998		
	Rotational	•	•	•	1.1631	35.014	-.0011	.016
305	Irrotational	3.9260	1.0551	1.1496	1.8856	39.326		
	Rotational	•	•	•	1.8862	39.322	.0006	-.004
1320	Irrotational	•	3.7609	4.0467	1.8811	38.150		
	Rotational	•	•	•	1.8836	38.201	.0025	.041

TABLE IV

EQUATIONS OF THE TWELVE SHOCK FRONTS

A(2.3604):	$x = .00051 + .14089\ y + .021571\ y^2 - .0004826\ y^3$
A(2.7296):	$x = -.00045 + .21503\ y + .017628\ y^2 - .0004089\ y^3$
A(3.2188):	$x = -.00019 + .43879\ y + .016428\ y^2 - .0004080\ y^3$
A(3.9260):	$x = -.00012 + .54276\ y + .016086\ y^2 - .0004468\ y^3$
B(2.4431):	$x = -.00134 + .24045\ y + .019465\ y^2 - .0004315\ y^3$
B(2.8387):	$x = -.00046 + .40333\ y + .016134\ y^2 - .0003658\ y^3$
B(3.3694):	$x = -.00005 + .52581\ y + .014625\ y^2 - .0003360\ y^3$
B(4.1538):	$x = -.00007 + .62818\ y + .014956\ y^2 - .0004476\ y^3$
C(2.0665):	$x = .00025 + .13050\ y + .019890\ y^2 - .0003524\ y^3$
C(2.3604):	$x = -.00086 + .31332\ y + .016952\ y^2 - .0003122\ y^3$
C(2.7296):	$x = -.00077 + .44802\ y + .016448\ y^2 - .0003467\ y^3$
C(3.2188):	$x = -.00039 + .56032\ y + .016834\ y^2 - .0004147\ y^3$

TABLE V

EQUATIONS OF CURVES THROUGH END-POINTS

Group A:	$x = 5.78203 - 1.84042\ y + .38190\ y^2 - .02358\ y^3$
Group B:	$x = 1.88961 + .09620\ y + .08069\ y^2 - .00649\ y^3$
Group C:	$x = 10.10739 - 2.35313\ y + .33239\ y^2 - .01443\ y^3$

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TABLE VI.

11-POINT GRAM-TSHEBYSHEFF POLYNOMIAL WORKSHEET

Step 1. Divide the interval of the argument into 10 equal parts and find the corresponding values of the function. These values are listed as $\phi(X)$. The transformed interval is $0 \leq X \leq 1$.

X	X^2	X^3	X^4	X^5
.00000	.00000	.00000	.00000	.00000
.10000	.01000	.00100	.00010	.00001
.20000	.04000	.00800	.00160	.00032
.30000	.09000	.02700	.00810	.00243
.40000	.16000	.06400	.02560	.01024
.50000	.25000	.12500	.06250	.03125
.60000	.36000	.21600	.12960	.07776
.70000	.49000	.34300	.24010	.16807
.80000	.64000	.51200	.40960	.32768
.90000	.81000	.72900	.65610	.59049
1.00000	1.00000	1.00000	1.00000	1.00000

X	$N_0(X)$	$N_1(X)$	$N_2(X)$	$N_3(X)$	$N_4(X)$	$N_5(X)$	$\phi^*(X)$	$\phi(X)$	$\phi^* - \phi = \epsilon$
.0	1	5	75	30	18	3	1.66666	1.66667	-.00001
.1	1	4	30	-6	-18	-6	1.66802	1.66797	.00005
.2	1	3	-5	-22	-18	-1	1.67163	1.67167	-.00004
.3	1	2	-30	-23	-3	4	1.67724	1.67726	-.00002
.4	1	1	-45	-14	12	4	1.68461	1.68458	.00003
.5	1	0	-50	0	18	0	1.69360	1.69358	.00002
.6	1	-1	-45	14	12	-4	1.70420	1.70420	0
.7	1	-2	-30	23	-3	-4	1.71653	1.71651	.00002
.8	1	-3	-5	22	-18	1	1.73090	1.73097	-.00007
.9	1	-4	30	6	-18	6	1.74788	1.74781	.00007
1.0	1	-5	75	-30	18	-3	1.76828	1.76829	-.00001
D_i	11	22	286	143	143	52			

Step 3. $\phi^*(X) = b_0 + b_1 X + \ldots + b_5 X^5$

j	0	1	2	3	4	5		
	1						a_0	1.702683
	1	-30					a_1	-.050158
	1	-120	120				a_2	.014318
	1	-286	750	-250			a_3	-.000612
	1	-625	3125	-2500	1250		a_4	.000463
	1	-1411	11625	-16375	18750	-2500	a_5	-.000038
	1	18	18	9	9	3		
b_j	1.66666	.00149	.12579	-.04247	-.01486	.03167		

Step 2. $a_i = \frac{1}{D_i} \Sigma N_i(X)\,\phi(X)$

$$a_2 = \frac{\Sigma N_2(X)\,\phi(X)}{D_2}$$

$$b_2 = \frac{120a_2 + 750a_3 + \ldots + 11625a_5}{18}$$

$$M_0 = 1.66666 + .00149\chi + .12579\chi^2 - .04247\chi^3 - .01486\chi^4 + .03167\chi^5$$

$$\chi = 4.24570\lambda - 1.85254 \quad (\lambda \text{ in radians})$$

Argument : $25^\circ \leq \lambda \leq 38.495^\circ$

Function : M_0

Identification : 25° Cone. $M_0' = 2.3604$

LIST OF FIGURES

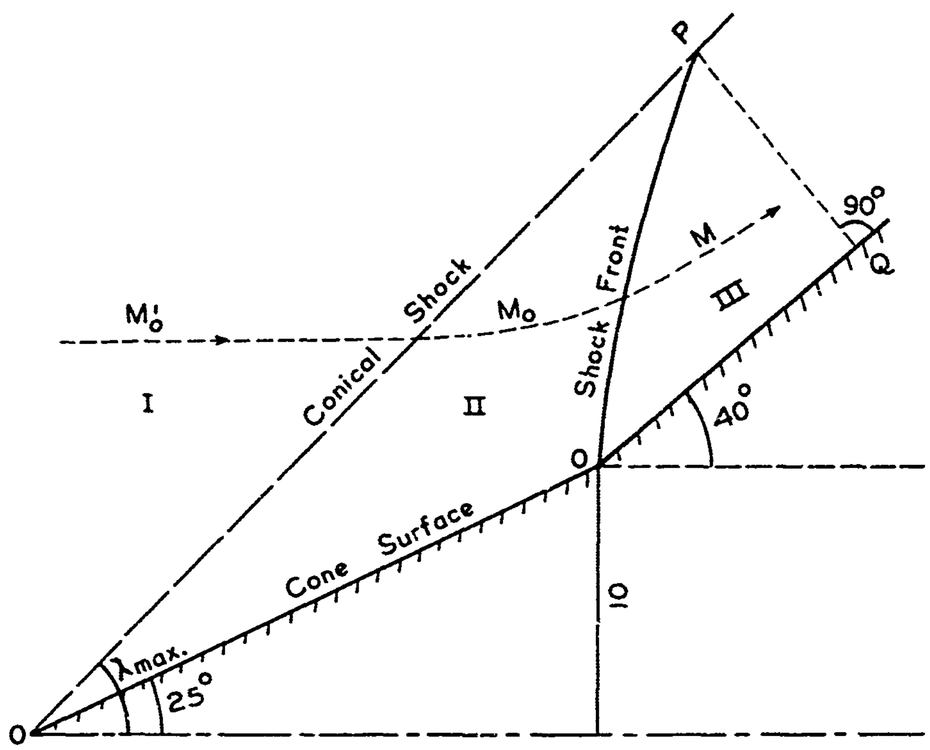


Fig. 1.

SCHEMATIC DIAGRAM OF SYSTEM

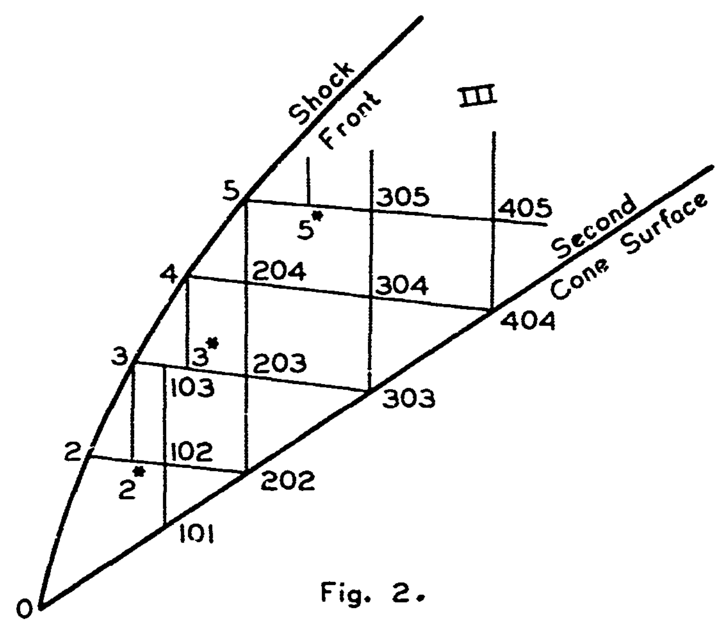


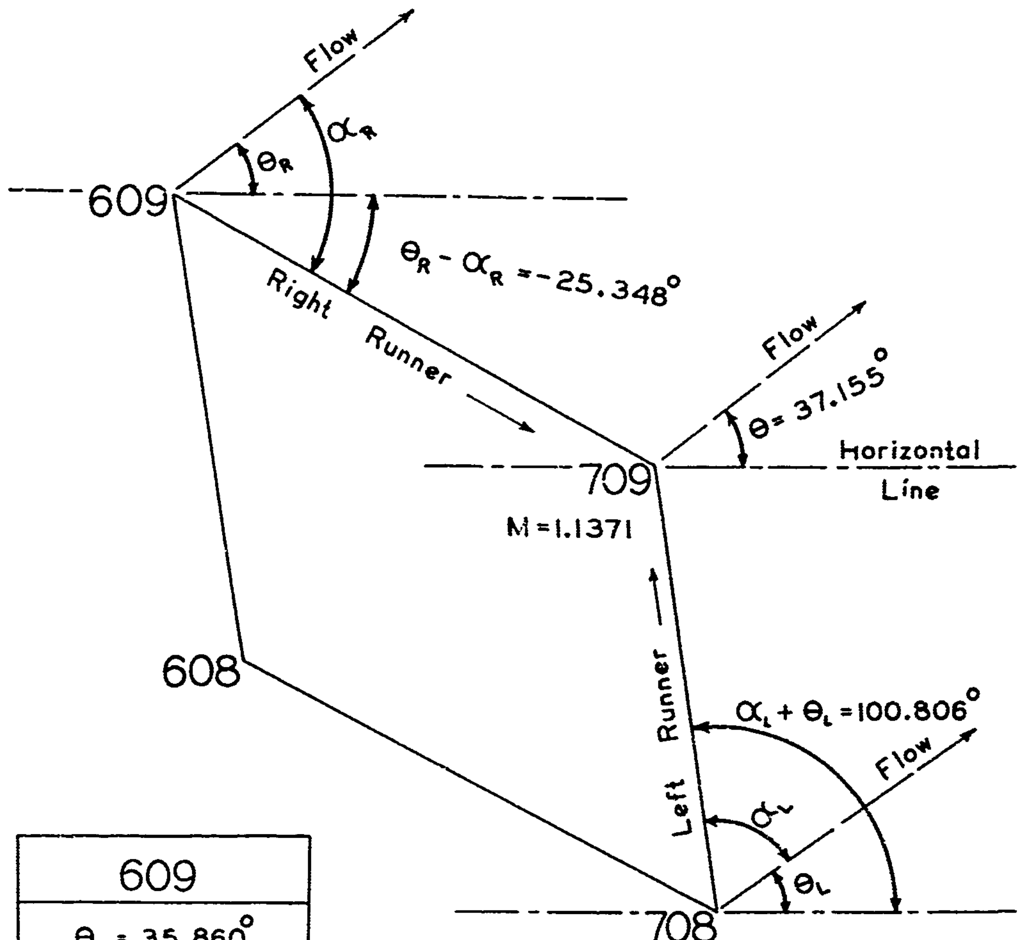
Fig. 2.

DIAGRAM SHOWING METHOD OF NUMBERING POINTS

Fig. 3.

DIAGRAM AT A NET POINT

(25°-40° Double Cone, $M_o^1 = 2.3604$)



609
$\theta_R = 35.860^\circ$
$\alpha_R = 61.208^\circ$
M = 1.1411

708
$\theta_L = 38.561^\circ$
$\alpha_L = 62.245^\circ$
M = 1.1300

θ = Direction of Flow

α = Arc Sin(1/M) = Mach Angle

$\theta_R - \alpha_R$ = Inclination of Right Runner

$\theta_L + \alpha_L$ Inclination of Left Runner

Not to Scale

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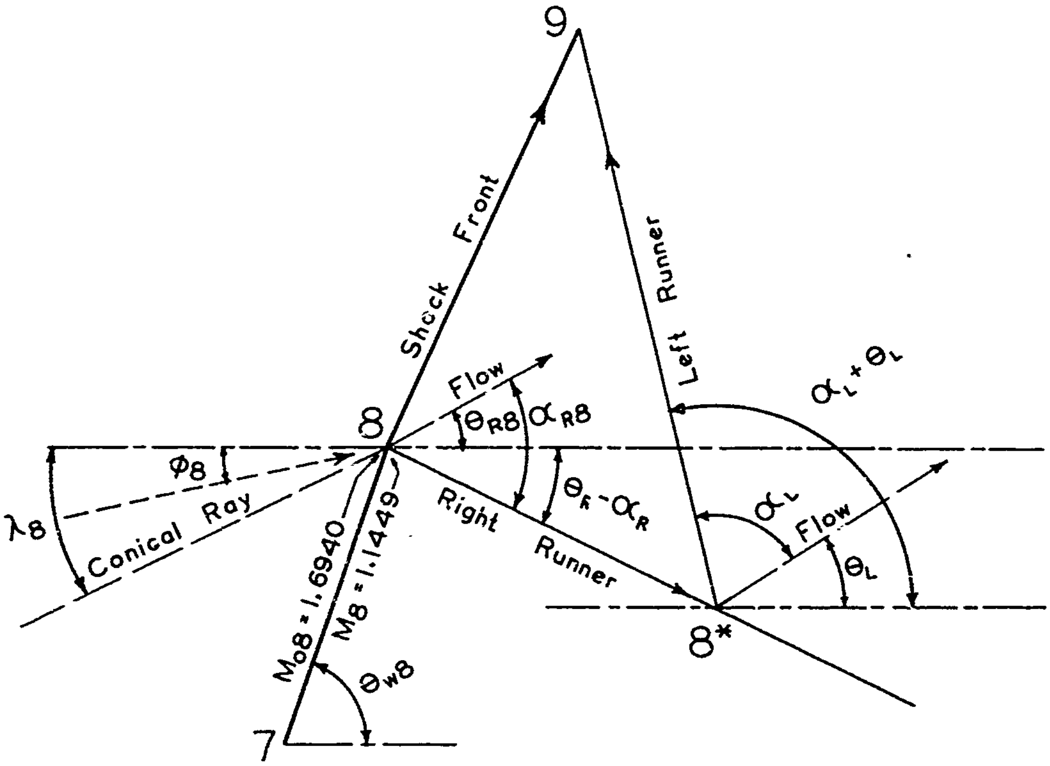
Fig. 4.

DIAGRAM AT A SHOCK POINT

(25°-40° Double Cone, $M_o' = 2.3604$)



Not to Scale

At Point 8
$\lambda_8 = 31.801^\circ$
$\phi_8 = 19.393^\circ$
$\delta_8 = 14.445^\circ$ (Wedge Angle)
$\theta_{w8} = 74.418^\circ$
$\theta_{R8} = 33.838^\circ$
$\alpha_{R8} = 60.859^\circ$

θ_{w8}, the inclination of the line 7-8, is the shock wave angle associated with the parameters at pt. 8.

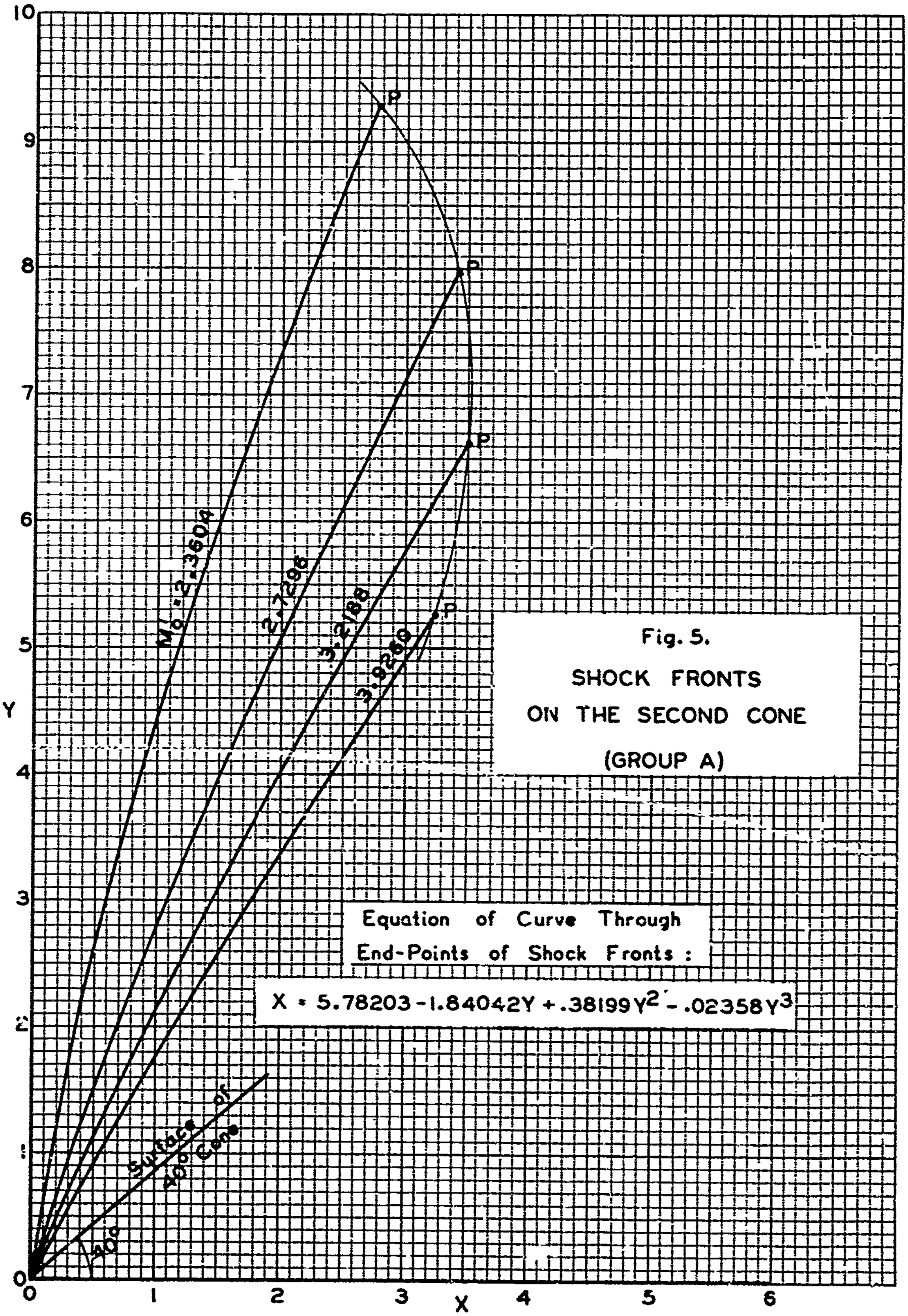


Fig. 5.
SHOCK FRONTS
ON THE SECOND CONE
(GROUP A)

Equation of Curve Through End-Points of Shock Fronts :

$$X = 5.78203 - 1.84042Y + .38199Y^2 - .02358Y^3$$

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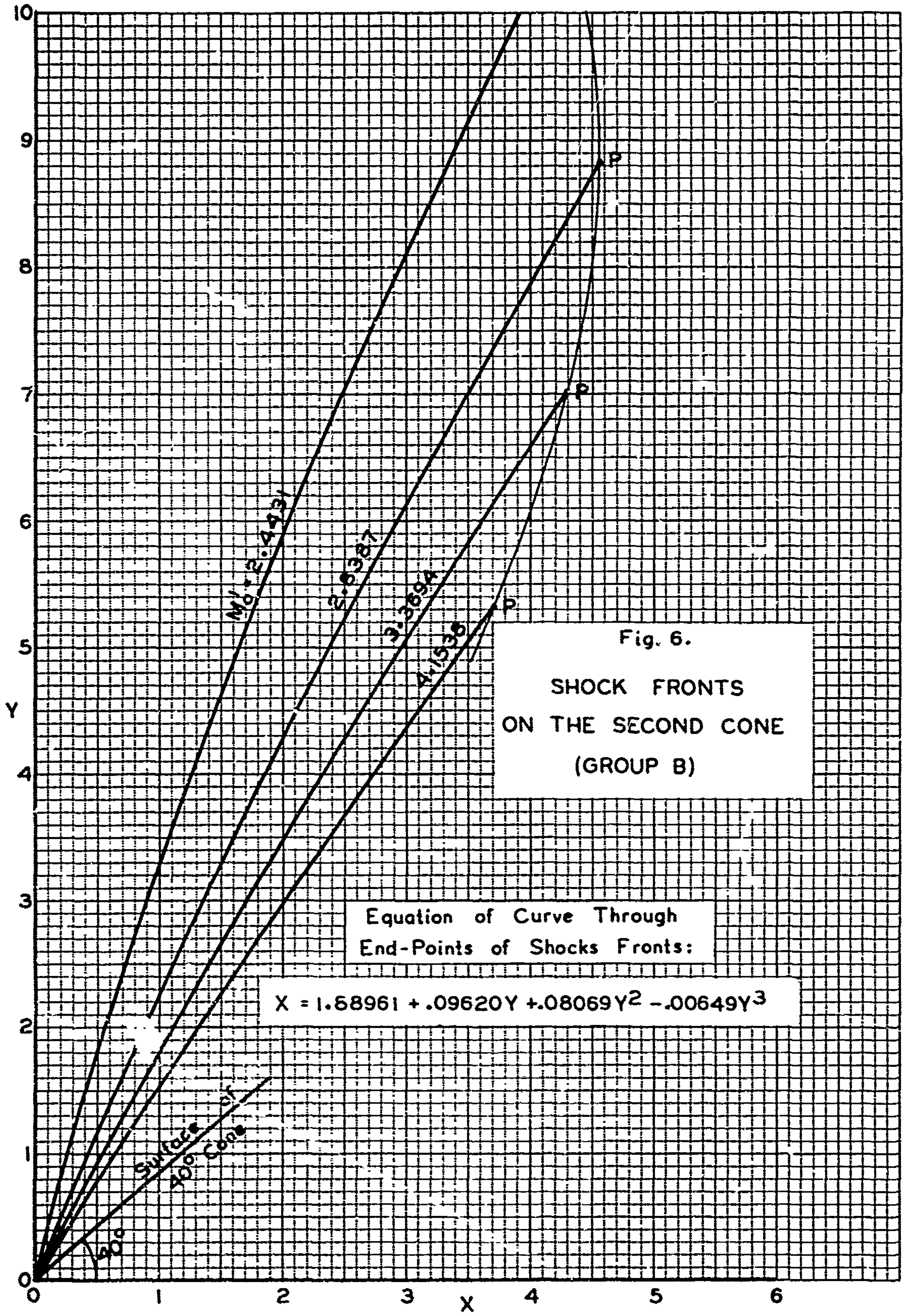

Fig. 6.
SHOCK FRONTS
ON THE SECOND CONE
(GROUP B)

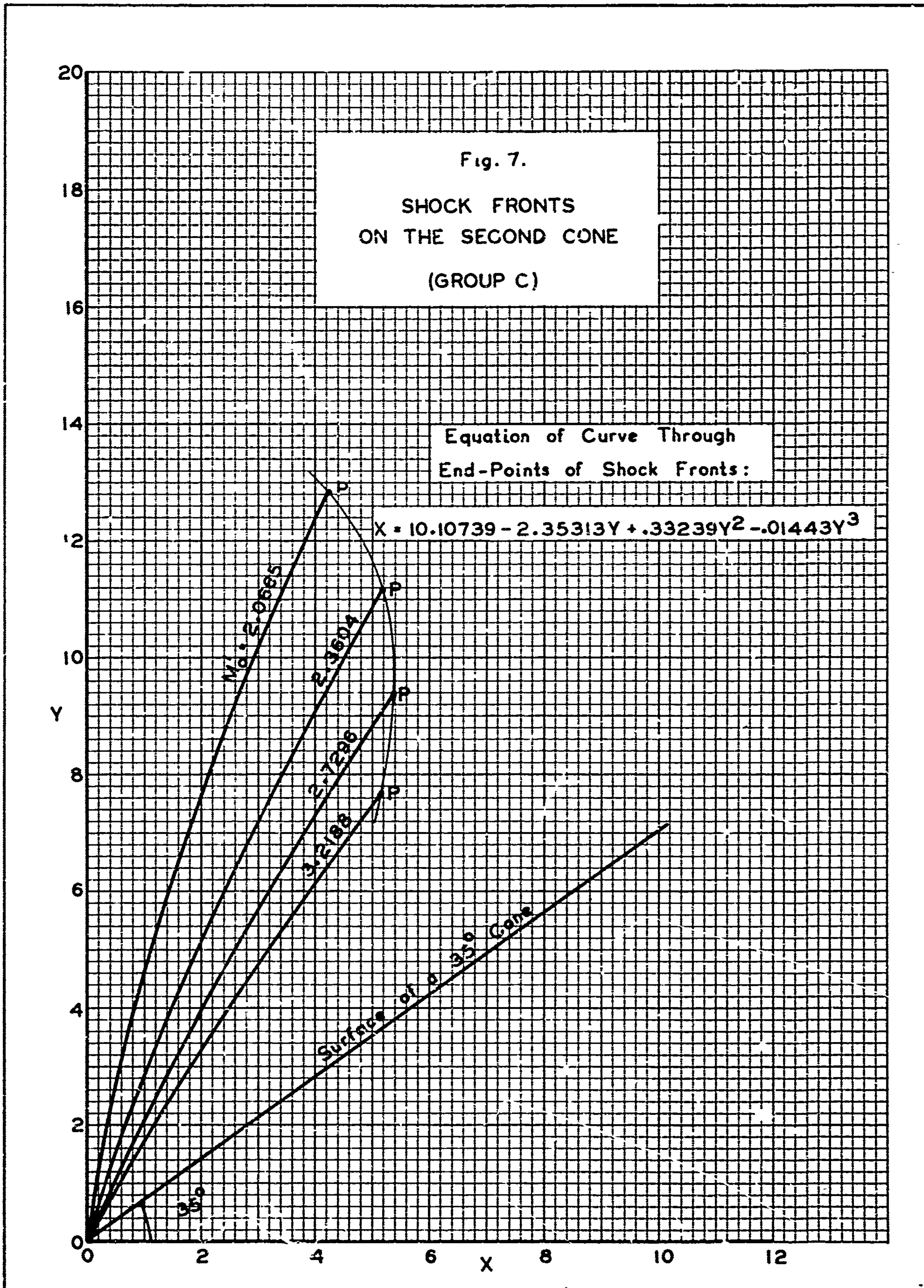
Fig. 7.
SHOCK FRONTS
ON THE SECOND CONE
(GROUP C)
Equation of Curve Through
End-Points of Shock Fronts:
X = 10.10739 - 2.35313Y + .33239Y2 - .01443Y3
M0 = 2.0665
2.3604
2.7296
3.2188
P
P
P
P
Surface of a 35° Cone
35°
Y
X
0
2
4
6
8
10
12
14
16
18
20

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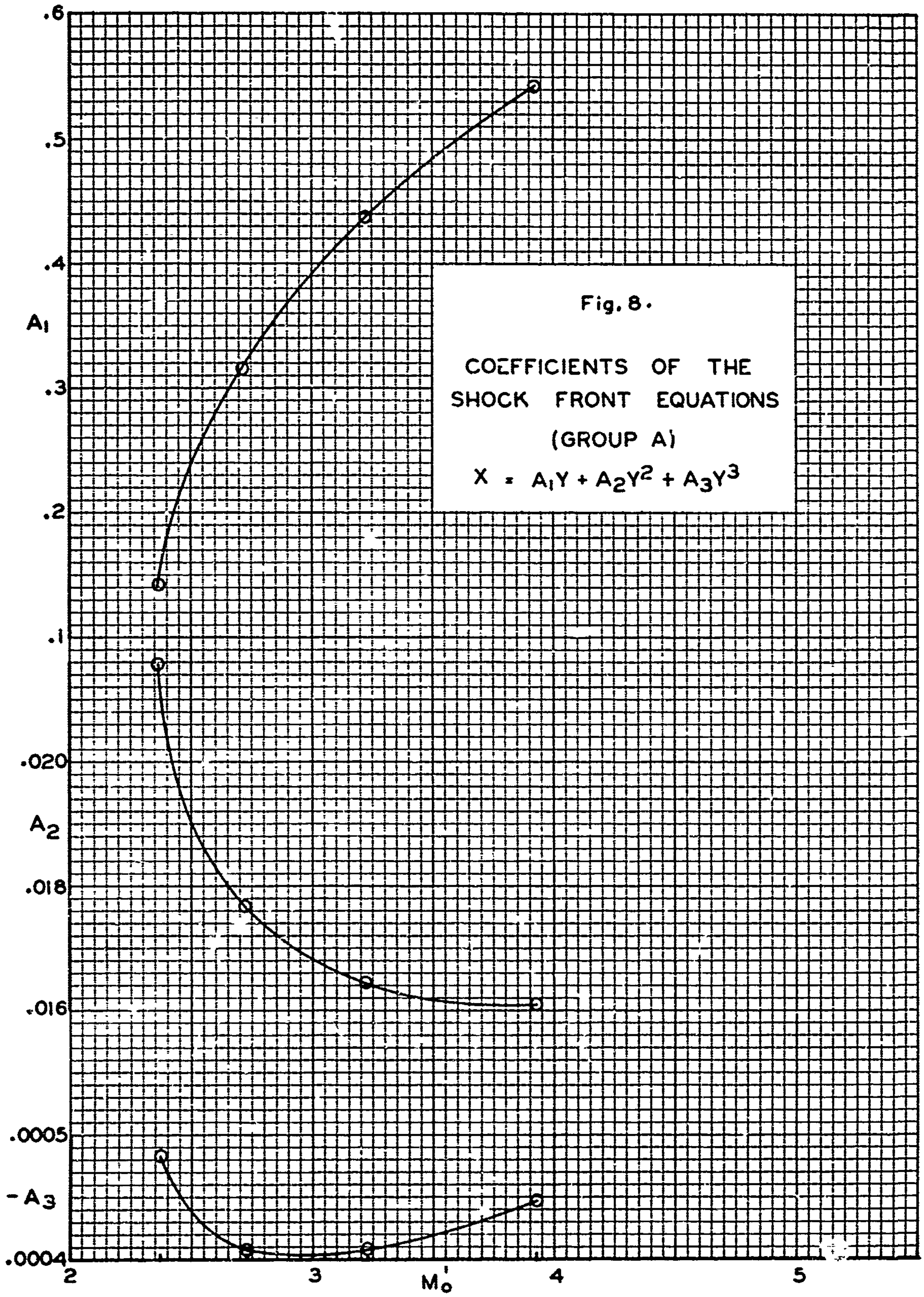

Fig. 8.

COEFFICIENTS OF THE SHOCK FRONT EQUATIONS (GROUP A)

$$X = A_1Y + A_2Y^2 + A_3Y^3$$

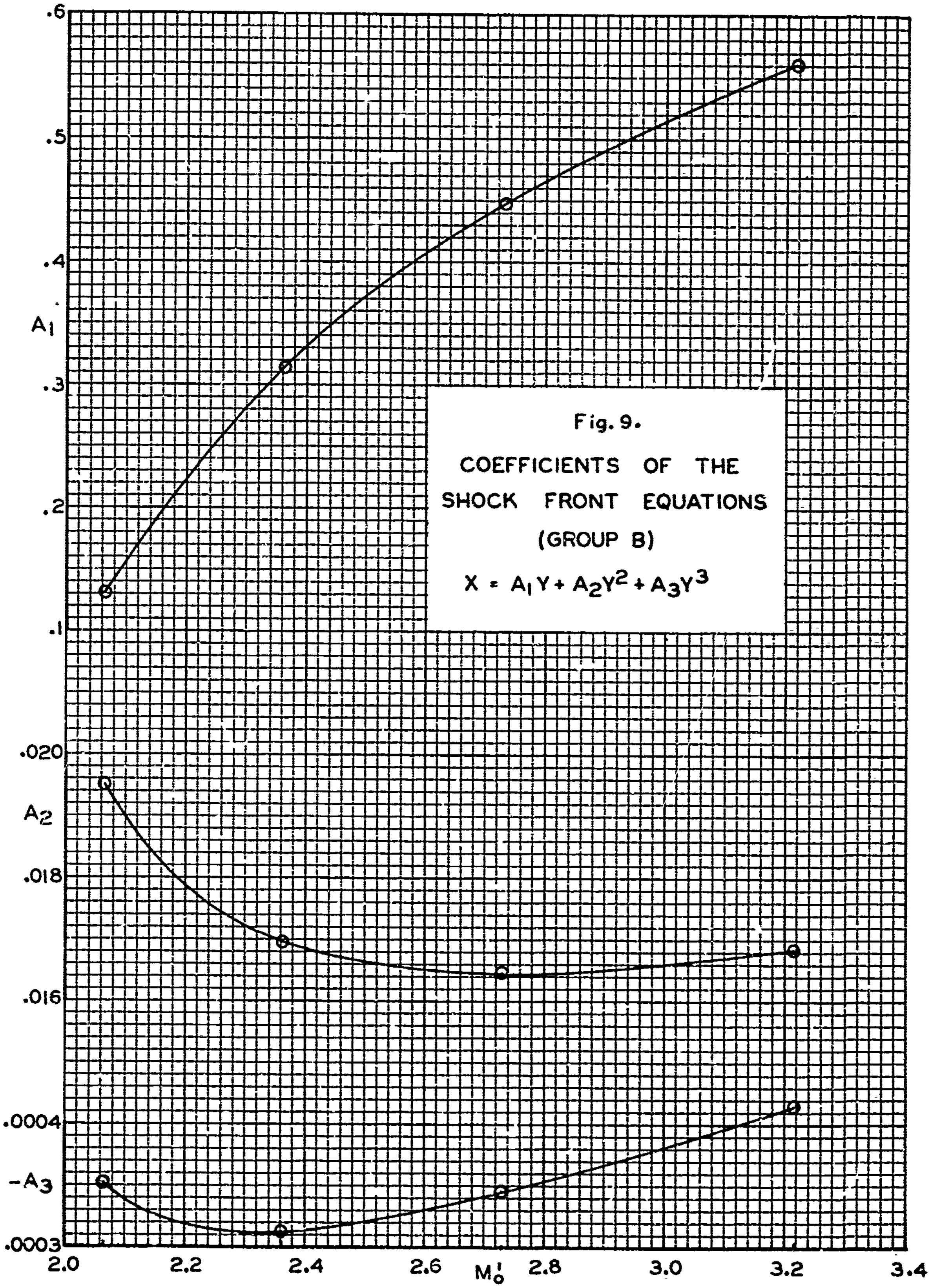

Fig. 9.

COEFFICIENTS OF THE SHOCK FRONT EQUATIONS (GROUP B)

$$X = A_1 Y + A_2 Y^2 + A_3 Y^3$$

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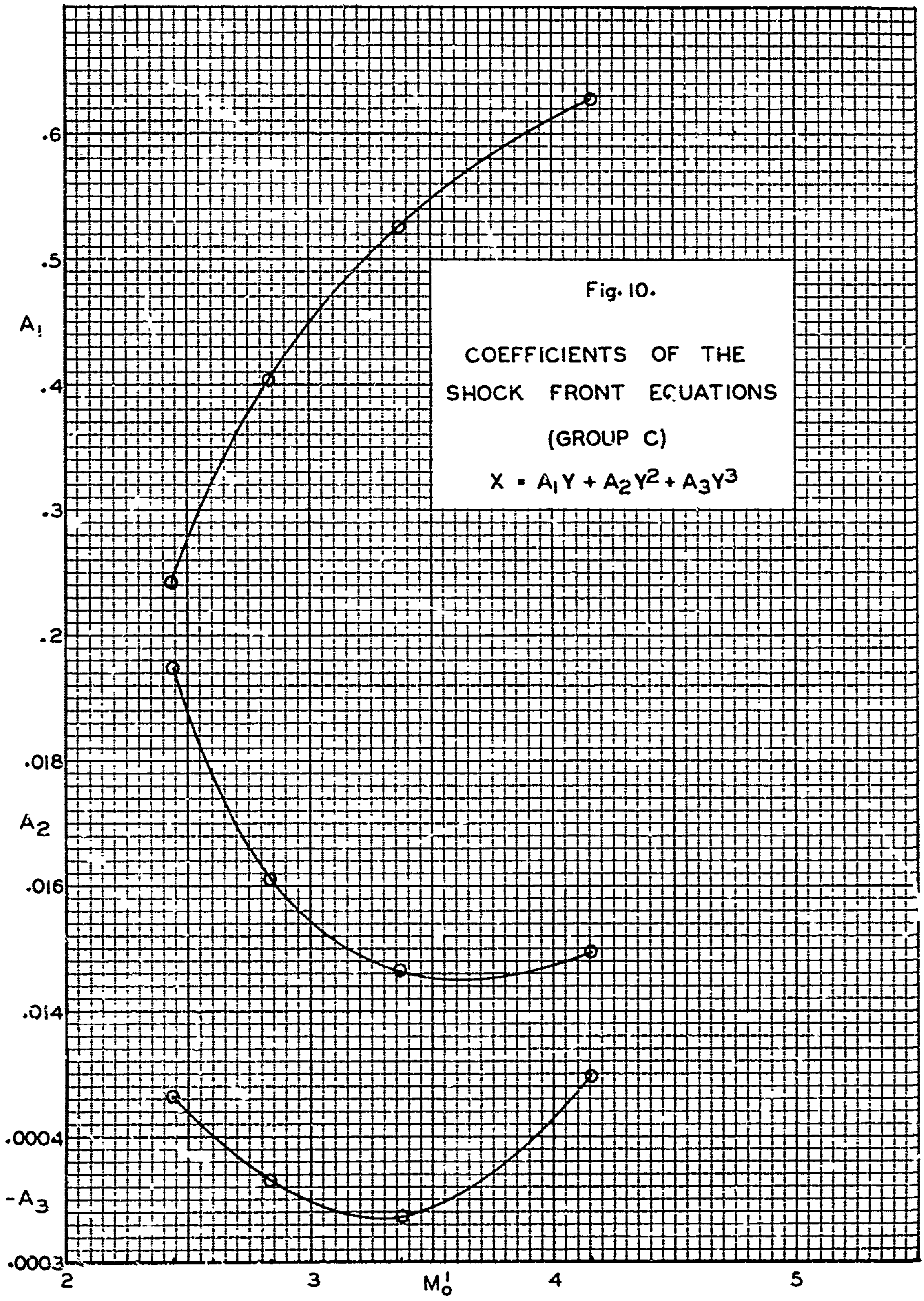

Fig. 11.

CURVES SHOWING THE ENTROPY EFFECT AT P

$M_r - M_i \cdot M_{rot.} - M_{irrot}$

$25^\circ - 40^\circ$ Double-Cone

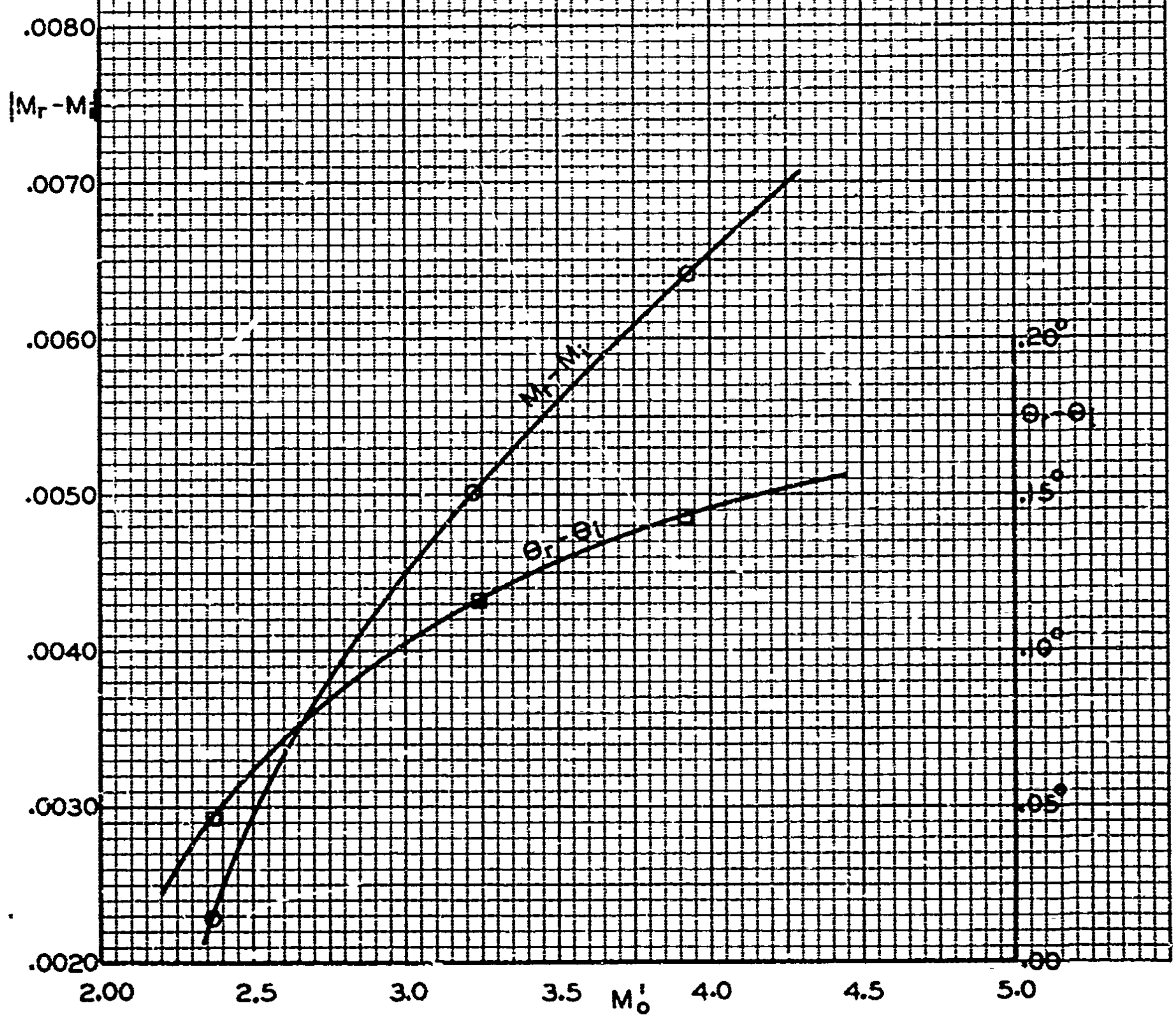

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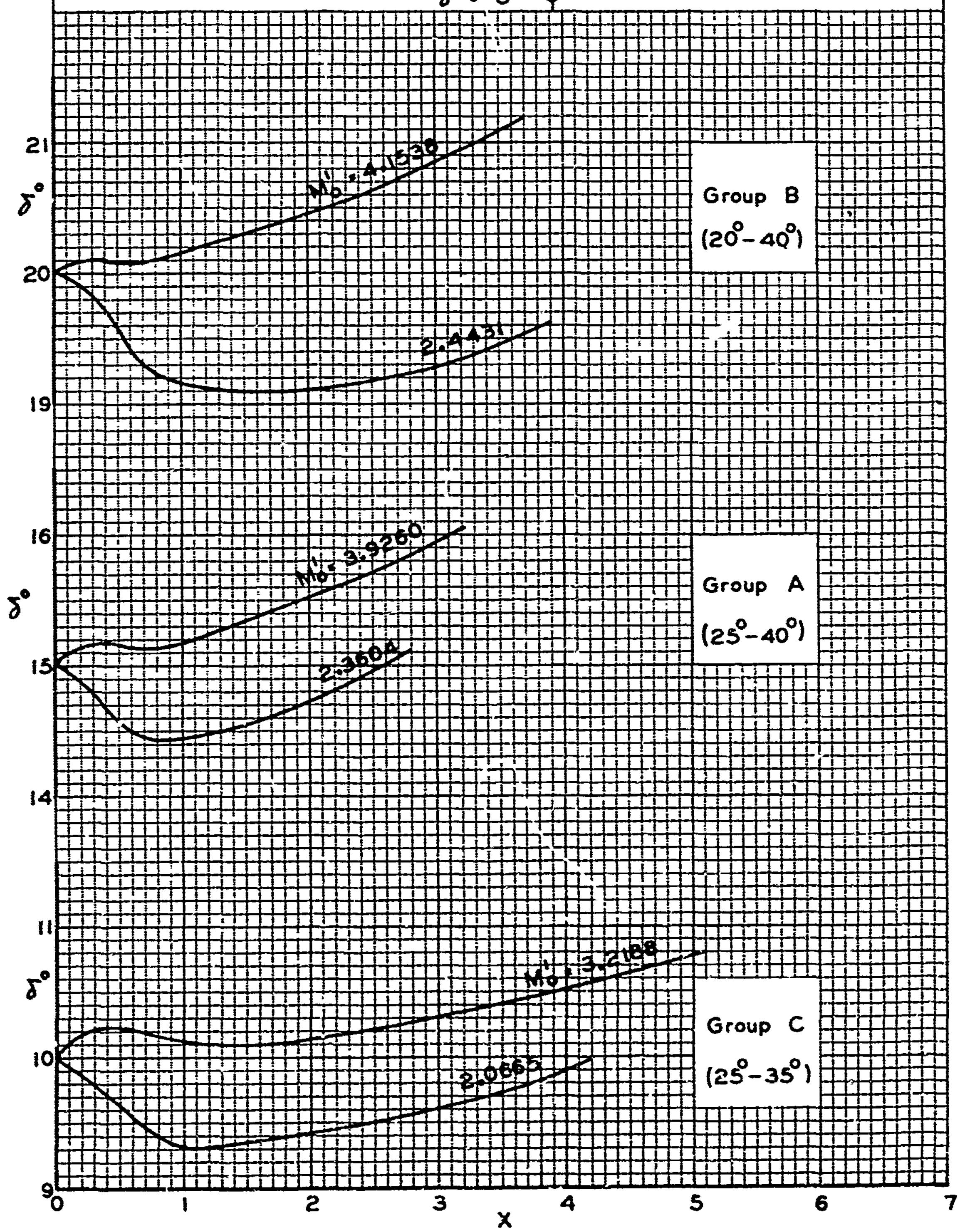
Fig. 12

FLOW DEFLECTION ACROSS SECOND SHOCK FRONT

$\delta = \theta - \phi$



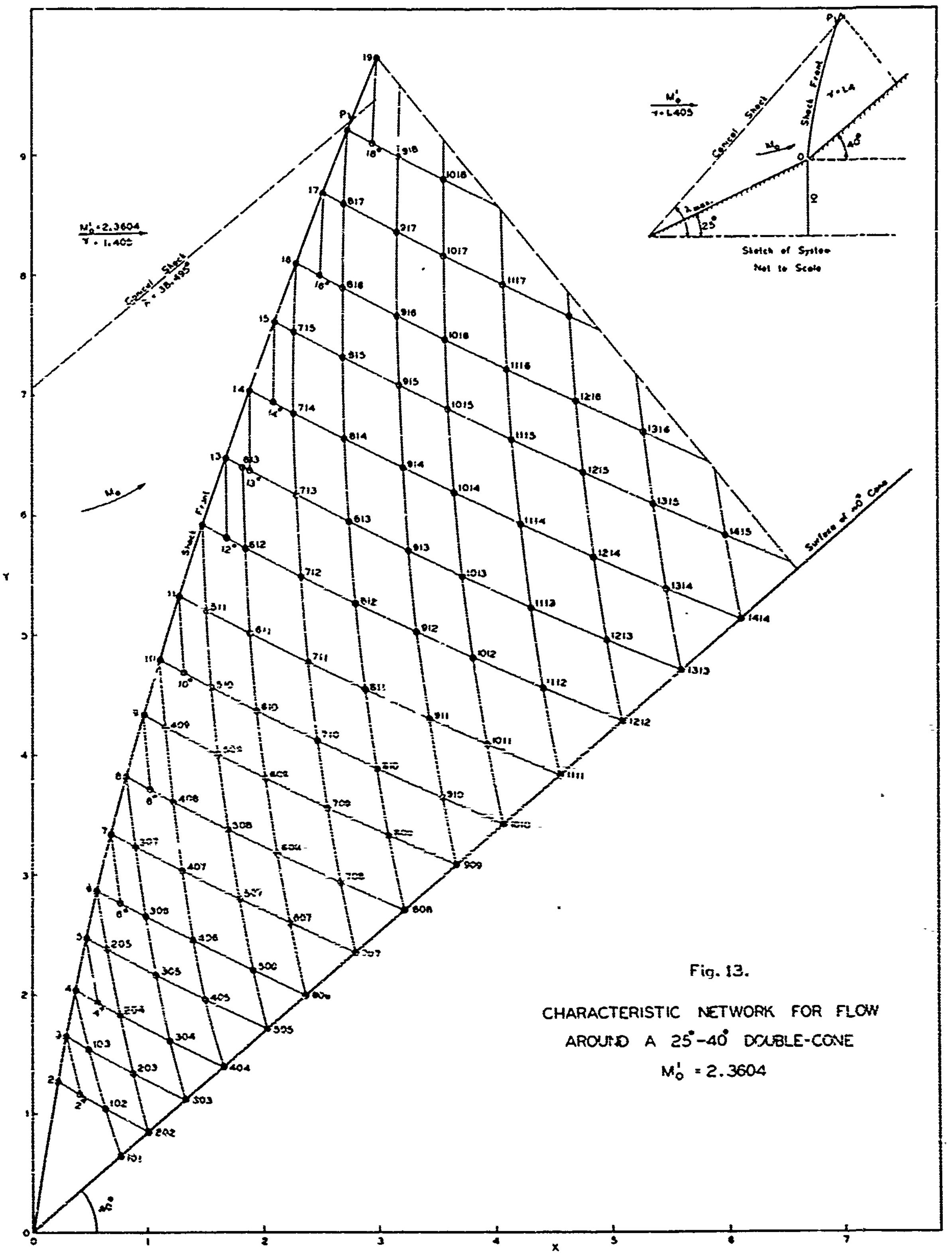


Fig. 13.

CHARACTERISTIC NETWORK FOR FLOW AROUND A 25°-40° DOUBLE-CONE
$M_0' = 2.3604$

TABLE VII

MACH NUMBER AND FLOW DIRECTION IN THE FIELDS AROUND DOUBLE-CONES

$M_o^! = 2.3604$ $25^\circ - 40^\circ$ $M_o^! = 2.7296$

P	x	y	M	θ°
101	.766	0.643	1.073	40.000
2	.222	1.281	1.087	37.595
2			1.671	22.699
2*	.424	1.167	1.088	38.241
102	.626	1.054	1.089	38.886
202	1.013	0.850	1.099	40.000
3	.293	1.654	1.096	36.929
3			1.673	22.122
103	.489	1.546	1.097	37.516
203	.878	1.337	1.105	38.569
303	1.329	1.115	1.105	40.000
4	.373	2.037	1.105	36.294
4			1.676	21.567
4*	.576	1.927	1.109	36.810
204	.762	1.826	1.112	37.281
304	1.199	1.605	1.110	38.599
404	1.653	1.387	1.110	40.000
5	.470	2.463	1.118	35.581
5			1.680	20.392
205	.654	2.365	1.121	36.013
305	1.075	2.150	1.118	37.212
405	1.514	1.933	1.116	38.494
505	2.021	1.696	1.115	40.000
6	.572	2.875	1.130	34.942
6			1.684	20.470
6*	.778	2.769	1.128	35.499
306	.978	2.665	1.126	36.041
406	1.403	2.453	1.123	37.217
506	1.893	2.217	1.121	38.604
606	2.378	1.995	1.120	40.000
7	.697	3.349	1.138	34.359
7			1.689	19.906
307	.889	3.251	1.136	34.853
407	1.297	3.045	1.132	35.921
507	1.769	2.813	1.128	37.183
607	2.237	2.592	1.126	38.458
707	2.792	2.343	1.125	40.000
8	.825	3.808	1.145	33.838
8			1.694	19.393
8*	1.032	3.703	1.143	34.353
408	1.218	3.608	1.140	34.816
508	1.673	3.382	1.136	35.973
608	2.125	3.164	1.133	37.143
708	2.663	2.916	1.130	38.561
808	3.196	2.682	1.129	40.000
9	.974	4.313	1.152	33.314

P	x	y	M	θ°
101	.400	0.336	1.350	40.000
2	.185	0.571	1.347	39.093
2			1.902	23.992
2*	.296	0.554	1.349	39.313
102	.408	0.536	1.352	39.534
202	.605	0.508	1.354	40.000
3	.316	0.960	1.352	38.375
3			1.903	23.368
103	.427	0.942	1.355	38.585
203	.622	0.911	1.356	39.031
303	1.015	0.852	1.356	40.000
4	.455	1.350	1.358	37.710
4			1.906	22.787
4*	.566	1.331	1.359	37.957
204	.646	1.317	1.359	38.136
304	1.033	1.254	1.358	39.063
404	1.426	1.196	1.358	40.000
5	.599	1.744	1.363	37.129
5			1.909	22.238
5*	.711	1.724	1.363	37.369
205	.679	1.730	1.363	37.300
305	1.058	1.664	1.361	38.187
405	1.444	1.602	1.360	39.084
505	1.840	1.544	1.360	40.000
6	.750	2.140	1.367	36.590
6			1.912	21.721
6*	.861	2.120	1.366	36.845
306	1.090	2.077	1.364	37.372
406	1.470	2.012	1.362	38.232
506	1.859	1.950	1.362	39.110
606	2.257	1.894	1.362	40.000
7	.906	2.537	1.370	36.110
7			1.916	21.232
7*	1.017	2.516	1.369	36.359
307	1.131	2.494	1.368	36.615
407	1.502	2.426	1.366	37.439
507	1.885	2.361	1.364	38.281
607	2.276	2.300	1.363	39.135
707	2.674	2.244	1.363	40.000
8	1.066	2.934	1.373	35.664
8			1.920	20.769
308	1.178	2.913	1.372	35.910
408	1.542	2.842	1.369	36.700
508	1.918	2.775	1.367	37.508
608	2.303	2.711	1.366	38.328
708	2.694	2.650	1.365	39.159
808	3.092	2.595	1.365	40.000

TABLE VII

MACH NUMBER AND FLOW DIRECTION IN THE FIELDS AROUND DOUBLE-CONES

$M_o' = 2.3604$ — $25^\circ - 40^\circ$ — $M_o' = 2.7296$

$M_o' = 2.3604$

P	x	y	M	θ°
9			1.700	18.863
409	1.152	4.222	1.150	33.739
509	1.590	4.003	1.145	34.793
609	2.025	3.790	1.141	35.860
709	2.542	3.545	1.137	37.155
809	3.058	3.311	1.134	38.473
909	3.644	3.058	1.133	40.000
10	1.113	4.765	1.158	32.878
10			1.705	18.412
10*	1.320	4.660	1.156	33.356
510	1.536	4.551	1.153	33.855
610	1.956	4.344	1.149	34.841
710	2.457	4.103	1.144	36.039
810	2.956	3.871	1.140	37.258
910	3.525	3.617	1.137	38.676
1010	4.048	3.397	1.136	40.000
11	1.284	5.294	1.165	32.407
11			1.712	17.913
511	1.491	5.190	1.162	32.867
611	1.895	4.988	1.158	33.772
711	2.377	4.754	1.152	34.868
811	2.858	4.526	1.148	35.983
911	3.406	4.275	1.144	37.281
1011	3.912	4.053	1.141	38.499
1111	4.524	3.796	1.139	40.000
12	1.466	5.837	1.172	31.962
12			1.719	17.426
12*	1.673	5.733	1.169	32.405
612	1.835	5.642	1.167	32.794
712	2.319	5.413	1.161	33.801
812	2.781	5.191	1.156	34.824
912	3.309	4.944	1.151	36.014
1012	3.797	4.723	1.147	37.132
1112	4.390	4.466	1.144	38.514
1212	5.015	4.208	1.142	40.000
13	1.659	6.388	1.178	31.545
13			1.726	16.954
613	1.834	6.300	1.176	31.906
713	2.280	6.079	1.170	32.834
813	2.725	5.863	1.164	33.776
913	3.234	5.621	1.159	34.869
1013	3.704	5.404	1.154	35.896
1113	4.276	5.148	1.150	37.167
1213	4.881	4.888	1.147	38.537
1313	5.517	4.629	1.145	40.000
14	1.833	6.866	1.183	31.209
14			1.732	16.560
14*	2.040	6.762	1.180	31.626
714	2.265	6.650	1.177	32.078

$M_o' = 2.7296$

P	x	y	M	θ°
9	1.232	3.335	1.377	35.246
9			1.924	20.325
9*	1.343	3.3[illegible]3	1.376	35.481
409	1.590	3.2[illegible]3	1.373	36.004
509	1.959	3.194	1.371	36.780
609	2.336	3.127	1.369	37.568
709	2.721	3.063	1.367	38.367
809	3.113	3.003	1.366	39.176
909	3.513	2.948	1.366	40.000
10	1.401	3.733	1.380	34.855
10			1.929	19.906
10*	1.511	3.711	1.379	35.085
410	1.643	3.684	1.377	35.359
510	2.005	3.612	1.374	36.105
610	2.376	3.543	1.372	36.863
710	2.755	3.476	1.370	37.631
810	3.140	3.414	1.369	38.410
910	3.534	3.354	1.368	39.204
1010	3.933	3.300	1.368	40.000
11	1.574	4.132	1.383	34.491
11			1.934	19.506
411	1.703	4.104	1.382	34.755
511	2.058	4.031	1.378	35.472
611	2.422	3.960	1.375	36.201
711	2.795	3.892	1.373	36.942
811	3.174	3.826	1.371	37.692
911	3.562	3.764	1.370	38.457
1011	3.954	3.706	1.369	39.225
1111	4.352	3.652	1.369	40.000
12	1.779	4.593	1.387	34.099
12			1.940	19.062
12*	1.890	4.570	1.385	34.317
512	2.127	4.519	1.383	34.785
612	2.483	4.446	1.379	35.484
712	2.848	4.376	1.377	36.192
812	3.220	4.307	1.374	36.911
912	3.601	4.242	1.372	37.645
1012	3.986	4.180	1.371	38.382
1112	4.377	4.122	1.370	39.127
1212	4.838	4.059	1.370	40.000
13	1.960	4.991	1.390	33.781
13			1.945	18.695
13*	2.071	4.967	1.388	33.995
513	2.193	4.941	1.387	34.233
613	2.543	4.867	1.383	34.907
713	2.901	4.795	1.380	35.590
813	3.266	4.725	1.377	36.284
913	3.641	4.657	1.375	36.992
1013	4.021	4.592	1.373	37.703
1113	4.406	4.531	1.372	38.422

TABLE VII

MACH NUMBER AND FLOW DIRECTION IN THE FIELDS AROUND DOUBLE-CONES

$M_o' = 2.3604$ | $25^\circ - 40^\circ$ | $M_o' = 2.7296$

$M_o' = 2.3604$

P	X	y	M	θ°
814	2.695	6.439	1.171	32.958
914	3.188	6.203	1.166	33.978
1014	3.644	5.989	1.161	34.936
1114	4.198	5.736	1.156	36.120
1214	4.785	5.477	1.151	37.398
1314	5.404	5.216	1.148	38.766
1414	5.954	4.996	1.147	40.000
15	2.045	7.432	1.188	30.841
15			1.740	16.109
715	2.262	7.325	1.185	31.263
815	2.677	7.120	1.180	32.078
915	3.151	6.889	1.174	33.022
1015	3.590	6.681	1.169	33.906
1115	4.124	6.432	1.163	34.997
1215	4.690	6.177	1.158	36.175
1315	5.289	5.916	1.154	37.439
1415	5.822	5.693	1.151	38.581
1515	6.475	5.433	1.149	40.000
16	2.277	8.029	1.194	30.48[illegible]
16			1.749	15.649
16*	2.484	7.926	1.191	30.877
816	2.676	7.831	1.188	31.241
916	3.133	7.607	1.182	32.114
1016	3.555	7.404	1.177	32.931
1116	4.070	7.161	1.171	33.938
1216	4.615	6.910	1.165	35.024
1316	5.191	6.652	1.160	36.187
1416	5.707	6.429	1.156	37.241
1516	6.339	6.166	1.153	38.553
1616	7.025	5.894	1.151	40.000
17	2.508	8.608	1.198	30.167
17			1.758	15.215
817	2.693	8.516	1.196	30.508
917	3.134	8.298	1.189	31.323
1017	3.542	8.100	1.184	32.083
1117	4.038	7.863	1.178	33.019
1217	4.563	7.617	1.172	34.025
1317	5.120	7.363	1.167	35.102
1417	5.618	7.142	1.162	36.078
1617	7.028	5.879	1.151	39.970
18	2.722	9.131	1.202	29.902
18			1.766	14.829
18*	2.930	9.028	1.199	30.275
918	3.150	8.919	1.196	30.670
1018	3.545	8.726	1.190	31.385
1118	4.025	8.494	1.184	32.264
1218	4.534	8.253	1.178	33.207
19	2.968	9.715	1.206	29.628
19			1.776	14.404

$M_o' = 2.7296$

P	X	y	M	θ°
1213	4.860	4.464	1.371	39.267
1313	5.257	4.412	1.371	40.000
14	2.144	5.388	1.393	33.483
14			1.950	18.342
514	2.264	5.362	1.391	33.713
614	2.608	5.287	1.387	34.364
714	2.960	5.214	1.384	35.023
814	3.319	5.142	1.381	35.693
914	3.687	5.073	1.378	36.376
1014	4.061	5.006	1.376	37.064
1114	4.441	4.942	1.374	37.759
1214	4.888	4.872	1.373	38.575
1314	5.280	4.815	1.372	39.285
1414	5.677	4.763	1.372	40.000
15	2.348	5.818	1.396	33.182
15			1.956	17.971
15*	2.458	5.794	1.394	33.387
615	2.684	5.743	1.391	33.809
715	3.030	5.669	1.388	34.444
815	3.382	5.596	1.384	35.089
915	3.744	5.525	1.381	35.748
1015	4.111	5.456	1.379	36.411
1115	4.484	5.390	1.377	37.081
1215	4.924	5.316	1.375	37.869
1315	5.310	5.256	1.374	38.554
1415	5.701	5.200	1.373	39.245
1515	6.130	5.144	1.373	40.000
16	2.538	6.214	1.398	32.920
16			1.962	17.640
16*	2.648	6.189	1.397	33.122
616	2.760	6.164	1.395	33.328
716	3.099	6.089	1.391	33.943
816	3.446	6.015	1.388	34.567
916	3.801	5.943	1.385	35.204
1016	4.163	5.872	1.382	35.845
1116	4.530	5.804	1.379	36.494
1216	4.963	5.728	1.377	37.256
1316	5.344	5.665	1.376	37.920
1416	5.730	5.606	1.375	38.589
1516	6.153	5.546	1.374	39.322
17	2.731	6.609	1.401	32.674
17			1.968	17.318
617	2.841	6.583	1.399	32.874
717	3.174	6.503	1.395	33.470
817	3.514	6.434	1.391	34.074
917	3.864	6.360	1.388	34.691
1017	4.220	6.288	1.385	35.311
1117	4.581	6.219	1.382	35.939
1217	5.008	6.140	1.379	36.678
1317	5.383	6.075	1.378	37.321

TABLE VII

MACH NUMBER AND FLOW DIRECTION IN THE FIELDS AROUND DOUBLE-CONES

$M_o' = 2.3604$ — $25^\circ - 40^\circ$ — $M_o' = 2.7296$

P	x	y	M	θ°
1019	3.563	9.420	1.197	30.670

P	x	y	M	θ°
18	2.926	7.002	1.403	32.444
18			1.974	17.003
18*	3.036	6.977	1.402	32.638
718	3.253	6.926	1.399	33.021
818	3.588	6.852	1.395	33.606
918	3.932	6.777	1.391	34.204
1018	4.282	6.704	1.388	34.805
1118	4.638	6.633	1.385	35.414
1218	5.058	6.553	1.382	36.130
19	3.124	7.394	1.405	32.224
19			1.981	16.694
19*	3.234	7.368	1.404	32.416
719	3.337	7.344	1.402	32.597
819	3.666	7.269	1.398	33.165
919	4.004	7.194	1.394	33.745
1019	4.348	7.120	1.391	34.328
1119	4.698	7.048	1.388	34.918
20	3.323	7.784	1.407	32.018
20			1.987	16.392
720	3.425	7.760	1.406	32.194
820	3.748	7.685	1.401	32.746
920	4.081	7.609	1.397	33.309
1020	4.419	7.535	1.394	33.875
21	3.510	8.145	1.409	31.839
21			1.993	16.115
821	3.828	8.069	1.404	32.376

TABLE VII

MACH NUMBER AND FLOW DIRECTION IN THE FIELDS AROUND DOUBLE-CONES

$25^\circ - 40^\circ$

$M_0^! = 3.2188$

P	x	y	M	θ°
101	.345	0.289	1.606	40.000
2	.245	0.548	1.600	39.257
2			2.179	24.097
2*	.321	0.549	1.603	39.346
102	.398	0.549	1.606	39.435
202	.660	0.554	1.607	40.000
3	.387	0.858	1.605	38.713
3			2.181	23.626
103	.464	0.859	1.607	38.798
203	.722	0.860	1.607	39.348
303	1.030	0.865	1.607	40.000
4	.534	1.169	1.609	38.201
4			2.183	23.182
4*	.610	1.169	1.609	38.361
204	.788	1.168	1.608	38.735
304	1.093	1.169	1.607	39.369
404	1.399	1.174	1.607	40.000
5	.683	1.480	1.610	37.793
5			2.185	22.760
5*	.760	1.479	1.610	37.952
205	.859	1.478	1.609	38.157
305	1.159	1.477	1.608	38.775
405	1.461	1.479	1.607	39.389
505	1.768	1.484	1.607	40.000
6	.835	1.790	1.612	37.413
6			2.188	22.361
206	.933	1.789	1.611	37.614
306	1.229	1.785	1.610	38.215
406	1.527	1.784	1.608	38.813
506	1.830	1.786	1.608	39.408
606	2.134	1.791	1.608	40.000
7	1.032	2.183	1.614	36.968
7			2.191	21.882
7*	1.108	2.181	1.613	37.121
307	1.322	2.176	1.612	37.549
407	1.615	2.172	1.610	38.128
507	1.912	2.171	1.609	38.705
607	2.212	2.172	1.608	39.278
707	2.595	2.178	1.608	40.000
8	1.189	2.492	1.616	36.640
8			2.195	21.523
8*	1.265	2.489	1.615	36.791
308	1.399	2.486	1.614	37.058
408	1.689	2.479	1.612	37.622
508	1.982	2.476	1.610	38.184
608	2.278	2.475	1.609	38.744
708	2.656	2.477	1.608	39.449

$M_0^! = 3.9260$

P	x	y	M	θ°
101	.400	0.336	1.889	40.000
2	.290	0.525	1.881	39.400
2			2.521	24.186
2*	.335	0.531	1.882	39.440
102	.469	0.543	1.888	39.561
202	.688	0.577	1.887	40.000
3	.397	0.716	1.883	39.097
3			2.522	23.909
3*	.441	0.722	1.884	39.136
103	.531	0.733	1.887	39.214
203	.748	0.760	1.887	39.648
303	.936	0.786	1.887	40.000
4	.505	0.907	1.885	38.803
4			2.523	23.643
4*	.549	0.913	1.886	38.842
104	.594	0.918	1.888	38.880
204	.808	0.944	1.886	39.307
304	.995	0.968	1.886	39.654
404	1.183	0.993	1.886	40.000
5	.614	1.098	1.887	38.520
5			2.524	23.385
105	.658	1.103	1.888	38.558
205	.870	1.127	1.887	38.979
305	1.056	1.150	1.886	39.322
405	1.242	1.174	1.886	39.663
505	1.429	1.199	1.886	40.000
6	.722	1.285	1.889	38.253
6			2.526	23.141
6*	.767	1.290	1.889	38.341
206	.933	1.308	1.887	38.668
306	1.117	1.330	1.886	39.006
406	1.301	1.353	1.886	39.343
506	1.487	1.376	1.886	39.676
606	1.670	1.401	1.886	40.000
7	.834	1.475	1.889	38.041
7			2.528	22.900
7*	.879	1.480	1.889	38.130
207	.998	1.493	1.888	38.364
307	1.180	1.513	1.887	38.697
407	1.363	1.535	1.886	39.029
507	1.546	1.557	1.885	39.358
607	1.728	1.581	1.885	39.678
707	1.913	1.606	1.885	40.000
8	.946	1.665	1.890	37.840
8			2.530	22.667
8*	.991	1.670	1.889	37.928
208	1.063	1.677	1.888	38.071

TABLE VII

MACH NUMBER AND FLOW DIRECTION IN THE FIELDS AROUND DOUBLE-CONES

$M_o^! = 3.2188$ $25^\circ - 40^\circ$ $M_o^! = 3.9260$

P	X	y	M	θ°
808	2.958	2.482	1.608	40.000
9	1.348	2.799	1.617	36.332
9			2.198	21.180
9*	1.424	2.797	1.616	36.482
309	1.480	2.795	1.616	36.592
409	1.765	2.787	1.613	37.143
509	2.055	2.781	1.612	37.692
609	2.347	2.778	1.610	38.238
709	2.721	2.777	1.609	38.926
809	3.019	2.779	1.609	39.465
909	3.319	2.785	1.609	40.000
10	1.509	3.106	1.619	36.044
10			2.202	20.851
10*	1.585	3.103	1.618	36.192
310	1.564	3.104	1.618	36.151
410	1.845	3.094	1.615	36.689
510	2.131	3.086	1.613	37.224
610	2.419	3.081	1.612	37.757
710	2.788	3.077	1.610	38.430
810	3.083	3.077	1.609	38.956
910	3.379	3.080	1.609	39.480
1010	3.677	3.086	1.609	40.000
11	1.672	3.412	1.620	35.772
11			2.206	20.534
11*	1.748	3.409	1.619	35.917
411	1.928	3.401	1.618	36.257
511	2.210	3.392	1.615	36.781
611	2.494	3.385	1.613	37.301
711	2.859	3.378	1.611	37.959
811	3.150	3.376	1.610	38.473
911	3.44[illegible]	3.377	1.610	38.985
1011	3.738	3.380	1.609	39.494
1111	4.034	3.385	1.609	40.000
12	1.836	3.717	1.622	35.514
12			2.210	20.229
12*	1.912	3.713	1.621	35.657
412	2.013	3.709	1.620	35.847
512	2.291	3.698	1.617	36.359
612	2.572	3.689	1.615	36.868
712	2.932	3.680	1.613	37.511
812	3.219	3.676	1.611	38.014
912	3.509	3.674	1.610	38.514
1012	3.801	3.675	1.610	39.013
1112	4.094	3.678	1.610	39.508
1212	4.390	3.684	1.610	40.000
13	2.002	4.020	1.623	35.271
13			2.214	19.934
413	2.102	4.016	1.622	35.457
513	2.376	4.003	1.619	35.957

P	X	y	M	θ°
308	1.244	1.696	1.887	38.400
408	1.425	1.717	1.886	38.727
508	1.607	1.738	1.886	39.052
608	1.787	1.760	1.885	39.368
708	1.971	1.784	1.885	39.686
808	2.156	1.809	1.885	40.000
9	1.058	1.854	1.890	37.648
9			2.532	22.441
9*	1.103	1.858	1.889	37.736
209	1.130	1.861	1.889	37.759
309	1.309	1.879	1.888	38.113
409	1.489	1.899	1.887	38.436
509	1.669	1.919	1.886	38.757
609	1.848	1.940	1.885	39.069
709	2.030	1.963	1.885	39.382
809	2.213	1.986	1.885	39.693
909	2.396	2.011	1.885	40.000
10	1.171	2.042	1.890	37.464
10			2.534	22.221
10*	1.216	2.047	1.889	37.552
210	1.198	2.045	1.889	37.516
310	1.375	2.062	1.888	37.836
410	1.553	2.080	1.887	38.156
510	1.732	2.100	1.886	38.472
610	1.909	2.120	1.885	38.780
710	2.090	2.141	1.885	39.090
810	2.272	2.164	1.884	39.396
910	2.453	2.187	1.884	39.700
1010	2.636	2.211	1.884	40.000
11	1.285	2.230	1.890	37.288
11			2.536	22.008
11*	1.330	2.234	1.890	37.369
311	1.442	2.245	1.889	37.570
411	1.619	2.262	1.888	37.885
511	1.796	2.280	1.886	38.197
611	1.972	2.299	1.886	38.501
711	2.151	2.320	1.885	38.807
811	2.331	2.341	1.884	39.110
911	2.512	2.364	1.884	39.410
1011	2.692	2.387	1.884	39.707
1111	2.874	2.411	1.884	40.000
12	1.[illegible]	2.417	1.890	37.113
12			2.539	21.801
12*	1.444	2.421	1.890	37.193
312	1.510	2.427	1.890	37.312
412	1.685	2.444	1.888	37.623
512	1.861	2.461	1.887	37.931
612	2.035	2.479	1.886	38.232
712	2.213	2.499	1.885	38.534
812	2.392	2.519	1.885	38.834

CONVAIR
A DIVISION OF GENERAL DYNAMICS CORPORATION
DAINGERFIELD, TEXAS

ORDNANCE
AEROPHYSICS
LABORATORY

TABLE VII

MACH NUMBER AND FLOW DIRECTION IN THE FIELDS AROUND DOUBLE-CONES

$25^\circ - 40^\circ$

$M_o' = 3.2188$

P	x	y	M	θ°
613	2.653	3.993	1.617	36.455
713	3.008	3.982	1.614	37.084
813	3.292	3.976	1.613	37.576
913	3.578	3.972	1.611	38.066
1013	3.867	3.971	1.611	38.553
1113	4.157	3.971	1.610	39.038
1213	4.450	3.975	1.610	39.521
1313	4.744	3.980	1.610	40.000
14	2.219	4.412	1.625	34.977
14			2.220	19.566
14*	2.295	4.408	1.624	35.115
514	2.488	4.398	1.622	35.464
614	2.761	4.385	1.619	35.948
714	3.110	4.372	1.616	36.559
814	3.390	4.364	1.614	37.038
914	3.672	4.358	1.613	37.515
1014	3.956	4.354	1.612	37.990
1114	4.242	4.352	1.611	38.462
1214	4.530	4.352	1.610	38.931
1314	4.821	4.355	1.610	39.398
1414	5.198	4.362	1.610	40.000
15	2.388	4.713	1.626	34.761
15			2.225	19.291
15*	2.464	4.708	1.626	34.898
515	2.578	4.702	1.624	35.103
615	2.847	4.688	1.621	35.577
715	3.192	4.673	1.618	36.176
815	3.468	4.664	1.616	36.645
915	3.747	4.656	1.614	37.112
1015	4.028	4.650	1.613	37.577
1115	4.311	4.647	1.612	38.040
1215	4.596	4.645	1.611	38.500
1315	4.883	4.646	1.611	38.958
1415	5.257	4.650	1.610	39.548
1515	5.548	4.655	1.611	40.000
16	2.558	5.012	1.628	34.558
16			2.229	19.023
16*	2.634	5.008	1.627	34.694
516	2.670	5.006	1.626	34.759
616	2.936	4.991	1.623	35.224
716	3.276	4.974	1.620	35.810
816	3.549	4.963	1.618	36.270
916	3.825	4.954	1.616	36.728
1016	4.102	4.947	1.614	37.183
1116	4.382	4.941	1.613	37.637
1216	4.665	4.938	1.612	38.088
1316	4.949	4.937	1.611	38.537
1416	5.319	4.938	1.611	39.116
1516	5.607	4.942	1.611	39.559
17	2.729	5.310	1.629	34.366

$M_o' = 3.9260$

P	x	y	M	θ°
912	2.571	2.540	1.884	39.130
1012	2.750	2.562	1.884	39.423
1112	2.930	2.586	1.884	39.713
1212	3.110	2.610	1.884	40.000
13	1.513	2.604	1.891	36.945
13			2.541	21.599
13*	1.558	2.608	1.890	37.025
313	1.579	2.610	1.890	37.062
413	1.753	2.625	1.889	37.370
513	1.927	2.642	1.887	37.675
613	2.100	2.659	1.886	37.972
713	2.276	2.677	1.885	38.270
813	2.453	2.697	1.885	38.566
913	2.631	2.717	1.884	38.859
1013	2.809	2.738	1.884	39.149
1113	2.988	2.760	1.884	39.435
1213	3.167	2.784	1.884	39.719
1313	3.346	2.808	1.884	40.000
14	1.628	2.790	1.891	36.785
14			2.544	21.402
14*	1.673	2.794	1.891	36.864
314	1.649	2.792	1.891	36.821
414	1.821	2.806	1.889	37.125
514	1.994	2.822	1.888	37.426
614	2.165	2.838	1.887	37.720
714	2.340	2.856	1.886	38.015
814	2.516	2.874	1.885	38.307
914	2.692	2.894	1.884	38.597
1014	2.869	2.914	1.884	38.883
1114	3.046	2.935	1.883	39.167
1214	3.224	2.957	1.883	39.447
1314	3.402	2.980	1.883	39.725
1414	3.580	3.004	1.883	40.000
15	1.747	2.975	1.892	36.631
15			2.546	21.210
15*	1.789	2.979	1.891	36.710
415	1.890	2.987	1.890	36.889
515	2.062	3.002	1.889	37.186
615	2.231	3.018	1.887	37.476
715	2.405	3.034	1.886	37.768
815	2.579	3.052	1.885	38.057
915	2.754	3.070	1.885	38.343
1015	2.930	3.090	1.884	38.626
1115	3.105	3.110	1.884	38.906
1215	3.282	3.131	1.883	39.184
1315	3.459	3.153	1.883	39.459
1415	3.636	3.176	1.883	39.731
1515	3.814	3.200	1.883	40.000
16	1.860	3.160	1.892	36.483
16			2.549	21.022

TABLE VII

MACH NUMBER AND FLOW DIRECTION IN THE FIELDS AROUND DOUBLE-CONES

$M_o' = 3.2188$ — $25^\circ - 40^\circ$ — $M_o' = 3.9260$

$M_o' = 3.2188$

P	x	y	M	θ°
17			2.234	18.762
17*	2.805	5.306	1.628	34.501
517	2.765	5.308	1.629	34.429
617	3.027	5.292	1.625	34.885
717	3.363	5.274	1.622	35.460
817	3.632	5.262	1.619	35.911
917	3.904	5.251	1.617	36.360
1017	4.179	5.243	1.616	36.806
1117	4.456	5.236	1.614	37.251
1217	4.735	5.231	1.613	37.694
1317	5.017	5.228	1.612	38.134
18	2.901	5.607	1.630	34.184
18			2.239	18.507
18*	2.977	5.602	1.629	34.315
618	3.119	5.593	1.627	34.561
718	3.451	5.574	1.624	35.125
818	3.718	5.560	1.621	35.567
918	3.987	5.549	1.619	36.007
1018	4.258	5.538	1.617	36.446
1118	4.532	5.530	1.615	36.882
1218	4.808	5.523	1.614	37.316
19	3.073	5.903	1.631	34.009
19			2.244	18.258
19*	3.150	5.898	1.630	34.140
619	3.214	5.893	1.629	34.251
719	3.542	5.873	1.626	34.805
819	3.805	5.858	1.623	35.238
919	4.071	5.845	1.621	35.670
1019	4.339	5.834	1.618	36.100
1119	4.610	5.824	1.617	36.529
20	3.247	6.197	1.632	33.844
20			2.249	18.013
620	3.311	6.192	1.631	33.953
720	3.634	6.170	1.627	34.497
820	3.894	6.155	1.625	34.923
920	4.157	6.141	1.622	35.347
21	3.393	6.442	1.633	33.712
21			2.254	17.810
21*	3.469	6.437	1.632	33.840
721	3.713	6.420	1.629	34.248
821	3.970	6.403	1.626	34.668
22	3.568	6.733	1.634	33.562
22			2.259	17.573

$M_o' = 3.9260$

P	x	y	M	θ°
16*	1.905	3.164	1.892	36.562
416	1.960	3.168	1.891	36.660
516	2.130	3.182	1.889	36.954
616	2.299	3.197	1.888	37.241
716	2.471	3.213	1.887	37.529
816	2.644	3.229	1.886	37.815
916	2.817	3.247	1.885	38.098
1016	2.991	3.265	1.884	38.378
1116	3.166	3.285	1.884	38.655
1216	3.341	3.305	1.883	38.929
1316	3.517	3.326	1.883	39.201
1416	3.693	3.348	1.883	39.470
1516	3.869	3.371	1.883	39.736
1616	4.046	3.395	1.883	40.000
17	1.976	3.344	1.893	36.3[illegible]2
17			2.552	20.838
417	2.031	3.348	1.892	36.438
517	2.200	3.362	1.890	36.729
617	2.366	3.376	1.889	37.012
717	2.537	3.391	1.887	37.297
817	2.709	3.407	1.886	37.580
917	2.881	3.424	1.885	37.860
1017	3.054	3.441	1.885	38.137
1117	3.227	3.460	1.884	38.411
1217	3.401	3.479	1.883	38.682
1317	3.575	3.499	1.883	38.951
1417	[illegible]750	3.520	1.883	39.217
1517	3.925	3.542	1.883	39.481
1617	4.101	3.565	1.883	39.742
1717	4.277	3.589	1.883	40.000
18	2.118	3.566	1.893	36.[illegible]78
18			2.556	20.621
18*	2.163	3.570	1.892	36.256
518	2.284	3.579	1.891	36.465
618	2.450	3.592	1.890	36.745
718	2.619	3.606	1.888	37.026
818	2.789	3.621	1.887	37.305
918	2.959	3.637	1.886	37.581
1018	3.130	3.654	1.885	37.854
1118	3.302	3.671	1.884	38.125
1218	3.474	3.689	1.884	38.393
1318	3.647	3.709	1.883	38.658
1418	3.820	3.729	1.883	38.921
1518	3.994	3.749	1.883	39.181
1618	4.169	3.771	1.883	39.439
1718	4.343	3.794	1.883	39.694
1818	4.555	3.822	1.883	40.000
19	2.235	3.749	1.893	36.048
19			2.559	20.445
19*	2.280	3.752	1.893	36.125
519	2.355	3.758	1.892	36.255

CONVAIR

A DIVISION OF GENERAL DYNAMICS CORPORATION

DAINGERFIELD, TEXAS

ORDNANCE
AEROPHYSICS
LABORATORY

TABLE VII

MACH NUMBER AND FLOW DIRECTION IN THE FIELDS AROUND DOUBLE-CONES

$M_0^{1} = 3.2188$ $25^\circ - 40^\circ$ $M_0^{1} = 3.9260$

P	x	y	M	θ°	P	x	y	M	θ°
					619	2.519	3.770	1.890	36.532
					719	2.687	3.784	1.889	36.810
					819	2.855	3.798	1.888	37.086
					919	3.025	3.813	1.886	37.359
					1019	3.194	3.829	1.885	37.629
					1119	3.365	3.846	1.885	37.897
					1219	3.536	3.863	1.884	38.162
					1319	3.708	3.882	1.883	38.425
					1419	3.880	3.901	1.883	38.685
					1519	4.052	3.921	1.883	38.942
					1619	4.226	3.942	1.882	39.197
					1719	4.399	3.963	1.882	39.450
					1819	4.609	3.990	1.883	39.753
					1919	4.784	4.014	1.883	40.000
					20	2.352	3.931	1.894	35.922
					20			2.562	20.272
					20*	2.397	3.934	1.893	36.000
					520	2.427	3.936	1.893	36.051
					620	2.589	3.948	1.891	36.325
					720	2.756	3.961	1.890	36.600
					820	2.923	3.975	1.888	36.873
					920	3.091	3.989	1.887	37.143
					1020	3.259	4.004	1.886	37.411
					1120	3.428	4.020	1.885	37.67[illegible]
					1220	3.598	4.037	1.884	37.938
					1320	3.769	4.054	1.884	38.198
					1420	3.940	4.073	1.883	38.455
					1520	4.111	4.092	1.883	38.710
					1620	4.283	4.112	1.[illegible]82	38.962
					1720	4.456	4.133	1.882	39.213
					1920	4.783	4.013	1.883	39.998
					21	2.469	4.112	1.894	35.802
					21			2.565	20.102
					21*	2.514	4.116	1.893	35.879
					521	2.499	4.115	1.894	35.853
					621	2.660	4.126	1.892	36.124
					721	2.825	4.138	1.890	36.396
					821	2.991	4.151	1.889	36.666
					921	3.158	4.165	1.88[illegible]	36.934
					1021	3.325	4.179	1.886	37.199
					1121	3.493	4.194	1.8[illegible]5	37.461
					1221	3.662	4.210	1.885	37.720
					1321	3.831	4.227	1.884	37.977
					1421	4.000	4.245	1.883	38.232
					1521	4.171	4.263	1.883	38.485
					1621	4.342	4.282	1.883	38.734
					22	2.587	4.293	1.894	35.686
					22			2.568	19.935
					22*	2.632	4.296	1.894	35.762
					622	2.732	4.303	1.893	35.928
					722	2.895	4.314	1.891	36.198

TABLE VII

MACH NUMBER AND FLOW DIRECTION IN THE FIELDS AROUND DOUBLE-CONES

$M_c^! = 3.2188$ $25^\circ - 40^\circ$ $M_o^! = 3.9260$

P	x	y	M	θ°	P	x	y	M	θ°
					822	3.060	4.327	1.889	36.465
					922	3.225	4.340	1.888	36.730
					1022	3.391	4.354	1.887	36.992
					1122	3.558	4.368	1.886	37.252
					1222	3.725	4.383	1.885	37.509
					1322	3.893	4.399	1.884	37.763
					1422	4.062	4.416	1.884	38.016
					1522	4.231	4.434	1.883	38.265
					23	2.705	4.473	1.895	35.573
					23			2.572	19.771
					23*	2.750	4.476	1.894	35.649
					623	2.804	4.480	1.893	35.738
					723	2.966	4.491	1.892	36.005
					823	3.129	4.502	1.890	36.270
					923	3.293	4.515	1.889	36.532
					1023	3.458	4.528	1.887	36.792
					1123	3.624	4.542	1.886	37.048
					1223	3.790	4.556	1.885	37.303
					1323	3.957	4.572	1.885	37.555
					1423	4.124	4.588	1.884	37.805
					24	2.823	4.653	1.895	35.464
					24			2.575	19.609
					624	2.876	4.656	1.894	35.553
					724	3.037	4.666	1.892	35.818
					824	3.199	4.677	1.891	36.080
					924	3.362	4.689	1.889	36.339
					1024	3.526	4.702	1.888	36.596
					1124	3.690	4.715	1.887	36.851
					1224	3.855	4.729	1.886	37.103
					1324	4.021	4.744	1.885	37.352
					25	2.962	4.862	1.895	35.342
					25			2.579	19.422
					25*	3.007	4.864	1.894	35.416
					725	3.121	4.871	1.893	35.604
					825	3.282	4.882	1.891	35.863
					925	3.443	4.893	1.890	36.119
					1025	3.605	4.905	1.889	36.374
					1125	3.768	4.917	1.887	36.625
					1225	3.932	4.931	1.886	36.874
					26	3.080	5.039	1.895	35.240
					26			2.583	19.264
					26*	3.125	5.042	1.895	35.314
					726	3.194	5.046	1.894	35.426
					826	3.353	5.056	1.892	35.683
					926	3.513	5.067	1.891	35.937
					1026	3.674	5.076	1.889	36.189
					27	3.199	5.217	1.895	35.141
					27			2.586	19.109
					27*	3.244	5.219	1.895	35.215

TABLE VII

MACH NUMBER AND FLOW DIRECTION IN THE FIELDS AROUND DOUBLE-CONES

$M_o' = 3.2188$ $25^\circ - 40^\circ$ $M_o' = 3.9260$

P	X	y	M	θ°	P	X	y	M	θ°
					727	3.267	5.221	1.894	35.252
					827	3.425	5.230	1.893	35.507
					927	3.584	5.240	1.891	35.758
					28	3.317	5.393	1.895	35.046
					28			2.590	18.955
					828	3.497	5.403	1.893	35.334

TABLE VII

MACH NUMBER AND FLOW DIRECTION IN THE FIELDS AROUND DOUBLE-CONES

$20^\circ - 40^\circ$

$M_o^I = 2.4431$

P	x	y	M	θ°
101	.800	0.671	1.086	40.000
2	.317	1.209	1.103	38.016
2			1.904	18.196
2*	.543	1.094	1.104	38.712
102	.694	1.017	1.105	39.177
202	1.024	0.859	1.117	40.000
3	.423	1.589	1.115	37.411
3			1.906	17.706
3*	.651	1.476	1.115	38.067
103	.569	1.516	1.115	37.832
203	.904	1.354	1.126	38.612
303	1.367	1.147	1.125	40.000
4	.543	1.991	1.126	36.804
4			1.909	17.219
204	.802	1.866	1.135	37.321
304	1.251	1.662	1.133	38.591
404	1.733	1.454	1.131	40.000
5	.703	2.484	1.150	35.942
5			1.913	16.667
5*	.934	2.379	1.148	36.552
305	1.134	2.288	1.146	37.079
405	1.597	2.085	1.142	38.343
505	2.189	1.837	1.138	40.000
6	.863	2.951	1.153	35.386
6			1.917	16.179
306	1.054	2.865	1.157	35.867
406	1.500	2.667	1.153	37.014
506	2.069	2.424	1.147	38.517
606	2.621	2.199	1.144	40.000
7	1.006	3.356	1.167	34.939
7			1.920	15.780
7*	1.238	3.253	1.164	35.508
407	1.438	3.153	1.162	36.000
507	1.989	2.925	1.156	37.389
607	2.524	2.703	1.152	38.761
707	2.999	2.516	1.149	40.000
8	1.188	3.850	1.174	34.443
8			1.925	15.319
408	1.381	3.765	1.172	34.895
508	1.911	3.533	1.166	36.162
608	2.427	3.315	1.161	37.413
708	2.885	3.130	1.158	38.545
808	3.463	2.906	1.155	40.000
9	1.350	4.276	1.181	34.046
9			1.929	14.944
9*	1.582	4.173	1.178	34.579

$M_o^I = 2.8387$

P	x	y	M	θ°
101	.700	0.587	1.384	40.000
2	.347	0.831	1.382	38.893
2			2.180	18.799
2*	.467	0.815	1.364	39.135
102	.713	0.783	1.388	39.627
202	.906	0.761	1.392	40.000
3	.497	1.180	1.387	38.352
3			2.182	18.348
3*	.617	1.163	1.389	38.587
103	.740	1.146	1.390	38.825
203	.932	1.122	1.394	39.184
303	1.288	1.081	1.395	40.000
4	.652	1.530	1.393	37.846
4			2.184	17.920
104	.773	1.513	1.394	38.074
204	.964	1.487	1.397	38.419
304	1.314	1.442	1.397	39.205
404	1.670	1.402	1.397	40.000
5	.813	1.885	1.399	37.367
5			2.187	17.512
5*	.934	1.867	1.400	37.579
205	1.002	1.857	1.401	37.699
305	1.347	1.810	1.400	38.455
405	1.698	1.766	1.399	39.221
505	2.056	1.726	1.400	40.000
6	.978	2.239	1.405	36.911
6			2.190	17.126
6*	1.099	2.221	1.406	37.116
206	1.046	2.229	1.405	37.026
306	1.385	2.179	1.403	37.754
406	1.731	2.132	1.402	38.492
506	2.084	2.089	1.402	39.243
606	2.443	2.050	1.402	40.000
7	1.148	2.595	1.410	36.480
7			2.193	16.757
7*	1.269	2.577	1.409	36.743
307	1.430	2.552	1.408	37.094
407	1.770	2.503	1.406	37.805
507	2.118	2.457	1.405	38.530
607	2.471	2.415	1.404	39.260
707	2.831	2.376	1.404	40.000
8	1.322	2.952	1.413	36.135
8			2.196	16.405
308	1.480	2.927	1.412	36.475
408	1.815	2.876	1.409	37.160
508	2.158	2.828	1.408	37.859
608	2.506	2.782	1.407	38.565

TABLE VII

MACH NUMBER AND FLOW DIRECTION IN THE FIELDS AROUND DOUBLE-CONES

$20^{\circ}-40^{\circ}$

$M_o^{\prime} = 2.4431$

P	x	y	M	θ°
509	1.864	4.049	1.175	35.225
609	2.365	3.835	1.169	36.387
709	2.809	3.652	1.165	37.438
809	3.371	3.429	1.161	38.790
909	3.864	3.242	1.158	40.000
10	1.553	4.791	1.188	33.605
10			1.935	14.513
510	1.825	4.672	1.184	34.203
610	2.308	4.463	1.179	35.270
710	2.737	4.283	1.[illegible]	[illegible]5.234
810	3.279	4.063	1.[illegible]	37.473
910	3.756	3.877	1.166	38.584
1010	4.355	3.654	1.163	40.000
11	1.802	5.400	1.195	33.126
11			1.941	14.031
11*	2.034	5.298	1.192	33.613
611	2.266	5.197	1.190	34.099
711	2.678	5.021	1.185	34.976
811	3.198	4.805	1.180	36.101
911	3.656	4.622	1.176	37.109
1011	4.233	4.398	1.171	38.396
1111	4.934	4.140	1.167	40.000
12	2.028	5.935	1.201	32.736
12			1.947	13.630
612	2.252	5.838	1.199	33.189
712	2.650	5.666	1.194	34.001
812	3.152	5.454	1.189	35.040
912	3.595	5.273	1.184	35.970
1012	4.152	5.052	1.179	37.157
1112	4.830	4.794	1.174	38.636
1212	5.448	4.572	1.170	40.000
13	2.255	6.460	1.207	32.382
13			1.954	13.252
13*	2.487	6.358	1.204	32.839
713	2.640	6.292	1.203	33.140
813	3.127	6.084	1.197	34.107
913	3.556	5.906	1.192	34.971
1013	4.095	5.688	1.187	36.072
1113	4.751	5.432	1.181	37.442
1213	5.351	5.208	1.176	38.708
1313	5.952	4.995	1.173	40.000
14	2.499	7.009	1.212	32.040
14			1.960	12.871
14*	2.731	6.908	1.210	32.482
714	2.647	6.945	1.211	32.322
814	3.118	6.741	1.205	33.223
914	3.533	6.567	1.201	34.027
1014	4.054	6.352	1.195	35.048
1114	4.689	6.099	1.188	36.318

$M_o^{\prime} = 2.8387$

P	x	y	M	θ°
708	2.860	2.740	1.406	39.279
808	3.220	2.702	1.406	40.000
9	1.553	3.415	1.416	35.722
9			2.201	15.969
9*	1.673	3.396	1.415	35.962
409	1.880	3.362	1.414	36.376
509	2.216	3.311	1.412	37.044
609	2.557	3.263	1.410	37.719
709	2.905	3.218	1.409	38.402
809	3.259	3.175	1.408	39.093
909	3.725	3.125	1.408	40.000
10	1.733	3.772	1.419	35.415
10			2.205	15.649
10*	1.853	3.752	1.418	35.651
410	1.937	3.738	1.418	35.816
510	2.268	3.686	1.415	36.461
610	2.604	3.636	1.413	37.113
710	2.947	3.588	1.412	37.774
810	3.296	3.543	1.411	38.442
910	3.755	3.489	1.410	39.321
1010	4.114	3.452	1.410	40.000
11	1.916	4.129	1.422	35.126
11			2.209	15.342
11*	2.037	4.109	1.421	35.359
411	1.999	4.115	1.421	35.286
511	2.324	4.061	1.419	35.911
611	2.655	4.009	1.417	36.541
711	2.993	3.959	1.415	37.181
811	3.337	3.912	1.413	37.828
911	3.790	3.855	1.412	38.679
1011	4.145	3.815	1.411	39.337
1111	4.504	3.779	1.411	40.000
12	2.102	4.486	1.424	34.856
12			2.213	15.044
12*	2.223	4.465	1.423	35.082
512	2.386	4.437	1.422	35.390
612	2.712	4.384	1.420	36.001
712	3.045	4.332	1.418	36.621
812	3.383	4.283	1.416	37.247
912	3.830	4.223	1.414	38.072
1012	4.180	4.180	1.413	38.710
1112	4.534	4.141	1.413	39.353
1212	4.893	4.105	1.413	40.[illegible]00
13	2.291	4.842	1.427	34.599
13			2.218	14.757
13*	2.411	4.821	1.426	34.822
513	2.452	4.814	1.425	34.897
613	2.773	4.759	1.423	35.490
713	3.101	4.706	1.421	36.090

TABLE VII

MACH NUMBER AND FLOW DIRECTION IN THE FIELDS AROUND DOUBLE-CONES

$M_o^{\prime} = 2.4431$ $20^{\circ}-40^{\circ}$ $M_o^{\prime} = 2.8387$

P	x	y	M	θ°
1214	5.269	5.876	1.183	37.491
1314	5.853	5.661	1.179	38.689
1414	6.483	5.440	1.176	40.000
15	2.752	7.565	1.217	31.719
15			1.967	12.499
15*	2.984	7.463	1.214	32.150
815	3.126	7.402	1.213	32.413
915	3.528	7.230	1.208	33.164
1015	4.033	7.019	1.203	34.116
1115	4.646	6.769	1.196	35.296
1215	5.208	6.549	1.190	36.386
1315	5.774	6.334	1.186	37.499
1415	6.386	6.111	1.181	38.718
1515	7.021	5.891	1.178	40.000
16	3.012	8.124	1.221	31.422
16			1.975	12.133
16*	3.245	8.023	1.219	31.840
816	3.150	8.064	1.220	31.669
916	3.539	7.896	1.215	32.373
1016	4.029	7.688	1.210	33.264
1116	4.622	7.443	1.203	34.366
1216	5.167	7.224	1.198	35.381
1316	5.715	7.012	1.193	36.417
1416	6.308	6.789	1.188	37.552
1516	6.925	6.567	1.183	38.747
1616	7.565	6.347	1.180	40.000
17	3.280	8.687	1.225	31.144
17			1.982	11.771
917	3.566	8.563	1.222	31.645
1017	4.040	8.359	1.217	32.482
1117	4.616	8.117	1.210	33.515
1217	5.143	7.901	1.205	34.465
1317	5.674	7.690	1.199	35.433
1417	6.250	7.469	1.194	36.491
1517	6.849	7.246	1.189	37.607
1617	7.471	7.025	1.185	38.777
1717	8.112	6.807	1.182	40.000
18	3.614	9.375	1.229	30.832
18			1.992	11.336
18*	3.847	9.273	1.227	31.228
1018	4.072	9.175	1.224	31.611
1118	4.626	8.938	1.218	32.571
1218	5.135	8.725	1.212	33.451
1318	5.647	8.517	1.207	34.345
1418	6.201	8.298	1.202	35.323
1518	6.779	8.076	1.197	36.351
1618	7.379	7.854	1.192	37.430
1718	8.000	7.633	1.186	38.559
19	3.895	9.942	1.232	30.595

P	x	y	M	θ°
813	3.435	4.656	1.419	36.698
913	3.875	4.593	1.417	37.497
1013	4.221	4.548	1.415	38.116
1113	4.570	4.506	1.415	38.741
1213	4.924	4.467	1.414	39.369
1313	5.282	4.432	1.414	40.000
14	2.482	5.198	1.429	34.357
14			2.223	14.478
14*	2.602	5.177	1.428	34.577
514	2.522	5.191	1.429	34.430
614	2.838	5.135	1.426	35.005
714	3.161	5.081	1.424	35.588
814	3.490	5.029	1.422	36.177
914	3.925	4.963	1.419	36.953
1014	4.265	4.916	1.418	37.554
1114	4.610	4.872	1.417	38.160
1214	4.960	4.831	1.416	38.770
1314	5.313	4.793	1.415	39.383
1414	5.670	4.758	1.415	40.000
15	2.675	5.553	1.431	34.130
15			2.227	14.207
15*	2.795	5.532	1.430	34.344
615	2.908	5.512	1.429	34.545
715	3.226	5.456	1.427	35.111
815	3.550	5.402	1.424	35.683
915	3.978	5.335	1.422	36.436
1015	4.315	5.287	1.420	37.020
1115	4.655	5.240	1.419	37.609
1215	5.000	5.197	1.418	38.202
1315	5.349	5.156	1.417	38.798
1415	5.702	5.118	1.417	39.398
1515	6.059	5.084	1.417	40.000
16	2.870	5.908	1.433	33.912
16			2.232	13.943
616	2.981	5.888	1.432	34.108
716	3.295	5.832	1.429	34.658
816	3.614	5.777	1.427	35.214
916	4.037	5.708	1.424	35.946
1016	4.368	5.657	1.422	36.514
1116	4.704	5.609	1.421	37.086
1216	5.045	5.564	1.420	37.662
1316	5.390	5.520	1.419	38.242
1416	5.738	5.480	1.418	38.826
1516	6.091	5.443	1.418	39.412
1616	6.446	5.409	1.418	40.000
17	3.053	6.237	1.435	33.722
17			2.237	13.703
17*	3.172	6.215	1.434	33.930
717	3.362	6.180	1.432	34.258
817	3.678	6.124	1.430	34.800

CONVAIR

A DIVISION OF GENERAL DYNAMICS CORPORATION

DAINGERFIELD, TEXAS

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TABLE VII

MACH NUMBER AND FLOW DIRECTION IN THE FIELDS AROUND DOUBLE-CONES

$M_o^{\prime} = 2.4431$ $20^\circ - 40^\circ$ $M_o^{\prime} = 2.8387$

P	x	y	M	θ°
19			2.001	10.978
1019	4.114	9.846	1.229	30.959
1119	4.652	9.612	1.223	31.866
1219	5.146	9.403	1.218	32.696
1319	5.643	9.197	1.213	33.538
1419	6.182	8.980	1.208	34.457
1519	6.743	8.760	1.203	35.422
20	4.165	10.478	1.234	30.386
20			2.010	10.638
20*	4.398	10.375	1.231	30.768
1120	4.689	10.247	1.228	31.248
1220	5.170	10.040	1.223	32.037
1320	5.654	9.837	1.218	32.835
1420	6.178	9.621	1.213	33.705
21	4.455	11.043	1.235	30.184
21			2.019	10.277
1221	5.207	10.711	1.227	31.389

P	x	y	M	θ°
917	4.094	6.053	1.427	35.514
1017	4.422	6.001	1.425	36.067
1117	4.754	5.952	1.423	36.624
1217	5.090	5.904	1.422	37.186
1317	5.431	5.859	1.420	37.751
1417	5.776	5.817	1.419	38.320
1517	6.124	5.777	1.419	38.892
1617	6.476	5.741	1.419	39.466
1717	6.805	5.710	1.419	40.000
18	3.251	6.590	1.436	33.527
18			2.242	13.450
18*	3.371	6.568	1.435	33.732
718	3.438	6.555	1.435	33.847
818	3.749	6.498	1.432	34.375
918	4.160	6.427	1.429	35.069
1018	4.483	6.373	1.427	35.607
1118	4.810	6.322	1.425	36.150
1218	5.142	6.273	1.424	36.697
1318	5.479	6.226	1.422	37.247
1418	5.820	6.182	1.421	37.801
1518	6.164	6.140	1.420	38.358
1618	6.512	6.101	1.420	38.917
1718	6.837	6.068	1.420	39.438
1818	7.192	6.035	1.420	40.000
19	3.451	6.943	1.438	33.343
19			2.247	13.200
19*	3.571	6.920	1.437	33.546
719	3.518	6.930	1.437	33.455
819	3.824	6.872	1.434	33.969
919	4.229	6.799	1.431	34.646
1019	4.548	6.745	1.429	35.170
1119	4.871	6.693	1.427	35.698
1219	5.199	6.642	1.426	36.231
1319	5.531	6.593	1.424	36.767
1419	5.868	6.547	1.423	37.307
1519	6.208	6.503	1.422	37.849
1619	6.552	6.462	1.421	38.394
1719	6.874	6.426	1.421	38.902
1819	7.224	6.390	1.420	39.450
1919	7.577	6.358	1.421	40.000
20	3.653	7.294	1.439	33.170
20			2.253	12.954
20*	3.773	7.271	1.438	33.368
820	3.902	7.246	1.437	33.583
920	4.302	7.172	1.433	34.242
1020	4.616	7.117	1.431	34.753
1120	4.935	7.063	1.429	35.268
1220	5.259	7.011	1.428	35.787
1320	5.587	6.961	1.426	36.310
1420	5.919	6.913	1.425	36.836
1520	6.256	6.867	1.424	37.365

TABLE VII

MACH NUMBER AND FLOW DIRECTION IN THE FIELDS AROUND DOUBLE-CONES

$M'_0 = 2.4431$ $20^\circ - 40^\circ$ $M'_0 = 2.8357$

P	x	y	M	θ°

P	x	y	M	θ°
1620	6.596	6.824	1.423	37.896
1720	6.914	6.786	1.422	38.391
1920	7.577	6.354	1.421	39.994
21	3.856	7.644	1.440	33.004
21			2.259	12.710
821	3.984	7.620	1.439	33.214
921	4.378	7.544	1.436	33.857
1021	4.688	7.488	1.433	34.356
1121	5.003	7.433	1.431	34.858
1221	5.322	7.380	1.430	35.364
1321	5.646	7.329	1.428	35.874
1421	5.975	7.279	1.427	36.387
1521	6.307	7.232	1.425	36.903
1621	6.643	7.186	1.424	37.422
22	4.074	8.017	1.441	32.838
22			2.265	12.453
22*	4.193	7.994	1.440	33.031
922	4.462	7.941	1.438	33.465
1022	4.768	7.884	1.435	33.951
1122	5.078	7.828	1.433	34.441
1222	5.393	7.773	1.431	34.934
1322	5.713	7.720	1.430	35.431
1422	6.037	7.669	1.428	35.931
1522	6.365	7.620	1.427	36.434
23	4.279	8.365	1.442	32.691
23			2.271	12.213
23*	4.399	8.341	1.441	32.883
923	4.544	8.312	1.439	33.115
1023	4.846	8.254	1.437	33.590
1123	5.152	8.197	1.435	34.068
1223	5.463	8.142	1.433	34.550
1323	5.779	8.088	1.432	35.036
24	4.485	8.711	1.442	32.553
24			2.278	11.974
924	4.628	8.682	1.441	32.781
1024	4.926	8.623	1.439	33.245
1124	5.229	8.566	1.437	33.713
1224	5.536	8.509	1.435	34.184
25	4.732	9.122	1.442	32.399
25			2.286	11.688
1025	5.025	9.062	1.440	32.851

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TABLE VII

MACH NUMBER AND FLOW DIRECTION IN THE FIELDS AROUND DOUBLE-CONES

$M_o^! = 3.3694$ | $20^\circ - 40^\circ$ | $M_o^! = 4.1538$

$M_o^! = 3.3694$

P	x	y	M	θ°
101	.600	0.503	1.661	40.000
2	.474	0.880	1.652	39.017
2			2.522	18.799
2*	.560	0.883	1.655	39.105
102	.688	0.887	1.660	39.236
202	1.075	0.902	1.663	40.000
3	.627	1.158	1.658	38.589
3			2.524	18.457
3*	.713	1.160	1.660	38.674
103	.755	1.162	1.662	38.717
203	1.137	1.173	1.663	39.462
303	1.412	1.185	1.664	40.000
4	.783	1.436	1.663	38.183
4			2.526	18.131
4*	.869	1.438	1.665	38.265
104	.826	1.437	1.664	38.223
204	1.203	1.446	1.664	38.952
304	1.475	1.455	1.664	39.477
404	1.749	1.467	1.664	40.000
5	.942	1.715	1.668	37.795
5			2.529	17.819
5*	1.028	1.716	1.668	37.969
205	1.272	1.720	1.665	38.466
305	1.541	1.728	1.665	38.980
405	1.811	1.737	1.665	39.491
505	2.085	1.750	1.665	40.000
6	1.103	1.993	1.669	37.519
6			2.531	17.519
6*	1.188	1.994	1.668	37.691
206	1.344	1.996	1.667	38.005
306	1.609	2.001	1.666	38.507
406	1.877	2.009	1.665	39.007
506	2.148	2.019	1.665	39.505
606	2.421	2.031	1.666	40.000
7	1.265	2.271	1.670	37.259
7			2.534	17.231
7*	1.350	2.271	1.669	37.430
207	1.419	2.272	1.669	37.567
307	1.681	2.275	1.667	38.058
407	1.945	2.281	1.667	38.547
507	2.213	2.289	1.666	39.035
607	2.483	2.299	1.666	39.519
707	2.755	2.311	1.666	40.000
8	1.428	2.548	1.671	37.015
8			2.537	16.955
8*	1.514	2.548	1.670	37.185
208	1.496	2.548	1.670	37.149

$M_o^! = 4.1538$

P	x	y	M	θ°
101	.383	0.321	1.970	40.000
2	.267	0.422	1.962	39.584
2			2.964	19.425
2*	.348	0.435	1.965	39.665
102	.428	0.448	1.968	39.747
202	.559	0.469	1.969	40.000
3	.439	0.689	1.965	39.200
3			2.965	19.086
103	.518	0.701	1.968	39.279
203	.648	0.721	1.968	39.527
303	.908	0.762	1.968	40.000
4	.611	0.953	1.969	38.838
4			2.967	18.765
4*	.692	0.965	1.968	38.992
204	.739	0.972	1.968	39.082
304	.996	1.011	1.967	39.546
404	1.253	1.051	1.968	40.000
5	.786	1.219	1.968	38.570
5			2.969	18.457
5*	.867	1.230	1.968	38.723
205	.833	1.225	1.968	38.659
305	1.087	1.261	1.967	39.115
405	1.341	1.300	1.967	39.561
505	1.597	1.340	1.967	40.000
6	.962	1.483	1.967	38.321
6			2.972	18.162
6*	1.043	1.494	1.967	38.463
306	1.180	1.513	1.967	38.706
406	1.431	1.549	1.966	39.144
506	1.684	1.587	1.966	39.576
606	1.940	1.627	1.967	40.000
7	1.140	1.747	1.967	38.079
7			2.975	17.879
7*	1.220	1.757	1.967	38.220
307	1.275	1.765	1.967	38.317
407	1.523	1.798	1.966	38.748
507	1.774	1.835	1.966	39.172
607	2.026	1.873	1.966	39.590
707	2.280	1.913	1.967	40.000
8	1.318	2.010	1.967	37.852
8			2.978	17.607
8*	1.398	2.020	1.966	37.993
308	1.372	2.017	1.967	37.947
408	1.617	2.048	1.966	38.371
508	1.865	2.082	1.965	38.788
608	2.115	2.118	1.965	39.199
708	2.366	2.156	1.966	39.603

TABLE VII

MACH NUMBER AND FLOW DIRECTION IN THE FIELDS AROUND DOUBLE-CONES

$20^\circ - 40^\circ$

$M_o' = 3.3694$

P	x	y	M	θ°
308	1.755	2.550	1.669	37.630
408	2.016	2.553	1.668	38.109
508	2.281	2.559	1.667	38.586
608	2.548	2.567	1.667	39.060
708	2.817	2.578	1.667	39.532
808	3.087	2.590	1.667	40.000
9	1.593	2.824	1.671	36.786
9			2.540	16.688
9*	1.679	2.824	1.671	36.943
309	1.831	2.824	1.670	37.222
409	2.089	2.826	1.669	37.691
509	2.351	2.830	1.668	38.158
609	2.615	2.836	1.668	38.623
709	2.881	2.844	1.667	39.085
809	3.149	2.855	1.667	39.544
909	3.417	2.867	1.668	40.000
10	1.759	3.099	1.672	36.559
10			2.544	16.430
10*	1.845	3.099	1.672	36.714
310	1.910	3.099	1.671	36.832
410	2.165	3.099	1.670	37.292
510	2.424	3.102	1.669	37.750
610	2.685	3.106	1.668	38.206
710	2.948	3.112	1.668	38.659
810	3.213	3.121	1.668	39.109
910	3.479	3.131	1.668	39.556
1010	3.747	3.144	1.666	40.000
11	1.927	3.374	1.673	36.344
11			2.547	16.180
11*	2.012	3.373	1.673	36.499
311	1.991	3.374	1.673	36.460
411	2.243	3.373	1.671	36.911
511	2.499	3.373	1.670	37.360
611	2.758	3.376	1.669	37.807
711	3.018	3.380	1.669	38.251
811	3.280	3.387	1.668	38.692
911	3.543	3.396	1.668	39.131
1011	3.808	3.406	1.668	39.567
1111	4.075	3.419	1.669	40.000
12	2.095	3.648	1.674	36.142
12			2.551	15.938
12*	2.181	3.647	1.674	36.293
412	2.323	3.646	1.673	36.546
512	2.576	3.645	1.671	36.987
612	2.832	3.646	1.670	37.425
712	3.089	3.649	1.670	37.861
812	3.348	3.654	1.669	38.294
912	3.609	3.661	1.669	38.724
1012	3.872	3.669	1.669	39.152
1112	4.136	3.680	1.669	39.578

$M_o' = 4.1538$

P	x	y	M	θ°
808	2.617	2.196	1.967	40.000
9	1.497	2.271	1.966	37.640
9			2.982	17.344
9*	1.578	2.281	1.966	37.778
409	1.713	2.298	1.966	38.011
509	1.959	2.330	1.965	38.422
609	2.205	2.364	1.965	38.826
709	2.453	2.400	1.965	39.223
809	2.703	2.438	1.966	39.615
909	2.953	2.478	1.967	40.000
10	1.677	2.532	1.966	37.438
10			2.985	17.090
10*	1.758	2.542	1.966	37.576
410	1.812	2.549	1.966	37.668
510	2.054	2.579	1.965	38.073
610	2.298	2.611	1.965	38.470
710	2.543	2.645	1.965	38.862
810	2.790	2.680	1.965	39.247
910	3.038	2.718	1.966	39.626
1010	3.287	2.758	1.967	40.000
11	1.858	2.792	1.966	37.250
11			2.989	16.843
11*	1.939	2.802	1.965	37.387
411	1.911	2.799	1.955	37.340
511	2.151	2.827	1.965	37.739
611	2.392	2.857	1.964	38.130
711	2.635	2.889	1.964	38.516
811	2.879	2.923	1.964	38.895
911	3.124	2.959	1.965	39.269
1011	3.371	2.997	1.965	39.637
1111	3.618	3.036	1.967	40.000
12	2.040	3.052	1.965	37.073
12			2.994	16.603
12*	2.121	3.061	1.965	37.206
512	2.250	3.075	1.964	37.419
612	2.488	3.104	1.964	37.805
712	2.728	3.134	1.964	38.185
812	2.970	3.166	1.964	38.559
912	3.213	3.200	1.964	38.927
1012	3.457	3.236	1.965	39.290
1112	3.702	3.273	1.965	39.648
1212	3.948	3.313	1.967	40.000
13	2.222	3.310	1.964	36.903
13			2.998	16.370
13*	2.303	3.319	1.964	37.035
513	2.350	3.324	1.964	37.113
613	2.586	3.351	1.963	37.493
713	2.824	3.379	1.963	37.868
813	3.063	3.410	1.963	38.236

CONVAIR
A DIVISION OF GENERAL DYNAMICS CORPORATION
DAINGERFIELD, TEXAS

ORDNANCE AEROPHYSICS LABORATORY

TABLE VII

MACH NUMBER AND FLOW DIRECTION IN THE FIELDS AROUND DOUBLE-CONES

$20^\circ - 40^\circ$

$M_o^! = 3.3694$

P	X	y	M	θ°
1212	4.401	3.693	1.669	40.000
13	2.264	3.921	1.675	35.949
13			2.555	15.702
13*	2.350	3.920	1.674	36.099
413	2.406	3.919	1.674	36.197
513	2.656	3.917	1.673	36.629
613	2.909	3.917	1.671	37.059
713	3.163	3.918	1.671	37.487
813	3.420	3.921	1.670	37.912
913	3.678	3.926	1.669	38.335
1013	3.938	3.933	1.669	38.755
1113	4.199	3.942	1.669	39.173
1213	4.462	3.953	1.669	39.588
1313	4.727	3.966	1.670	40.000
14	2.435	4.193	1.676	35.766
14			2.559	15.472
14*	2.520	4.192	1.675	35.915
414	2.490	4.193	1.675	35.862
514	2.737	4.189	1.674	36.287
614	2.987	4.187	1.673	36.709
714	3.239	4.187	1.672	37.129
814	3.493	4.189	1.671	37.547
914	3.748	4.193	1.670	37.962
1014	4.006	4.198	1.670	38.374
1114	4.265	4.205	1.670	38.785
1214	4.525	4.214	1.670	39.193
1314	4.787	4.225	1.670	39.598
1414	5.051	4.238	1.671	40.000
15	2.606	4.465	1.676	35.593
15			2.563	15.248
15*	2.691	4.463	1.676	35.739
515	2.820	4.461	1.675	35.958
615	3.068	4.458	1.674	36.373
715	3.317	4.457	1.672	36.786
815	3.568	4.457	1.672	37.196
915	3.821	4.459	1.671	37.604
1015	4.076	4.463	1.670	38.009
1115	4.333	4.468	1.670	38.412
1215	4.591	4.475	1.670	38.813
1315	4.850	4.485	1.670	39.212
1415	5.111	4.496	1.671	39.607
1515	5.373	4.509	1.671	40.000
16	2.778	4.735	1.677	35.427
16			2.567	15.029
16*	2.863	4.734	1.676	35.572
516	2.905	4.733	1.676	35.643
616	3.150	4.729	1.675	36.051
716	3.397	4.726	1.673	36.456
816	3.645	4.725	1.672	36.859
916	3.896	4.725	1.672	37.260

$M_o^! = 4.1538$

P	X	y	M	θ°
913	3.303	3.442	1.963	38.600
1013	3.545	3.476	1.964	38.957
1113	3.787	3.511	1.965	39.310
1213	4.031	3.549	1.965	39.658
1313	4.276	3.588	1.967	40.000
14	2.405	3.567	1.964	36.743
14			3.003	16.142
14*	2.486	3.575	1.964	36.875
514	2.451	3.572	1.964	36.819
614	2.685	3.597	1.963	37.194
714	2.920	3.624	1.963	37.564
814	3.157	3.653	1.963	37.927
914	3.395	3.683	1.963	38.286
1014	3.634	3.716	1.963	38.638
1114	3.875	3.749	1.964	38.986
1214	4.116	3.785	1.964	39.329
1314	4.358	3.822	1.966	39.667
1414	4.601	3.861	1.967	40.000
15	2.588	3.823	1.963	36.593
15			3.008	15.918
15*	2.669	3.831	1.963	36.722
615	2.785	3.843	1.963	36.908
715	3.018	3.869	1.962	37.272
815	3.252	3.896	1.962	37.631
915	3.488	3.925	1.962	37.984
1015	3.725	3.956	1.962	38.332
1115	3.963	3.988	1.963	38.675
1215	4.202	4.022	1.964	39.014
1315	4.443	4.057	1.965	39.347
1415	4.684	4.094	1.966	39.676
1515	4.926	4.133	1.967	40.000
16	2.772	4.078	1.962	36.448
16			3.013	15.698
16*	2.852	4.086	1.962	36.577
616	2.887	4.090	1.962	36.632
716	3.117	4.114	1.962	36.992
816	3.349	4.140	1.961	37.346
916	3.582	4.167	1.961	37.694
1016	3.817	4.196	1.962	38.038
1116	4.053	4.227	1.962	38.377
1216	4.290	4.259	1.963	38.711
1316	4.529	4.293	1.964	39.040
1416	4.768	4.328	1.965	39.365
1516	5.007	4.365	1.966	39.685
17	2.956	4.332	1.961	36.313
17			3.019	15.482
17*	3.036	4.340	1.961	36.441
617	2.990	4.335	1.961	36.367
717	3.218	4.358	1.961	36.722
817	3.447	4.383	1.961	37.072

TABLE VII

HACH NUMBER AND FLOW DIRECTION IN THE FIELDS AROUND DOUBLE-CONES

$M_o^{\prime} = 3.3694$ — $20^{\circ} - 40^{\circ}$ — $M_o^{\prime} = 4.1538$

$M_o^{\prime} = 3.3694$

P	x	y	M	θ°
1016	4.148	4.728	1.671	37.659
1116	4.402	4.732	1.671	38.055
1216	4.658	4.737	1.670	38.449
1316	4.915	4.745	1.670	38.841
1416	5.174	4.754	1.671	39.230
1516	5.434	4.765	1.671	39.616
1616	5.695	4.778	1.672	40.000
17	2.951	5.005	1.677	35.270
17			2.572	14.813
17*	3.036	5.003	1.677	35.414
517	2.992	5.004	1.677	35.340
617	3.234	4.999	1.675	35.741
717	3.478	4.995	1.674	36.139
817	3.724	4.993	1.673	36.536
917	3.972	4.992	1.672	36.930
1017	4.222	4.993	1.672	37.322
1117	4.474	4.995	1.671	37.712
1217	4.727	5.000	1.671	38.099
1317	4.982	5.005	1.671	38.484
1417	5.238	5.013	1.671	38.867
1517	5.496	5.023	1.671	39.247
1617	5.755	5.034	1.672	39.625
1717	6.015	5.047	1.672	40.000
18	3.124	5.274	1.677	35.122
18			2.577	14.602
18*	3.210	5.272	1.677	35.262
618	3.320	5.269	1.676	35.443
718	3.561	5.264	1.675	35.835
818	3.805	5.260	1.674	36.225
918	4.050	5.258	1.673	36.613
1018	4.298	5.258	1.672	36.998
1118	4.547	5.259	1.672	37.382
1218	4.798	5.262	1.671	37.763
1318	5.051	5.266	1.671	38.142
1418	5.305	5.272	1.671	38.519
1518	5.560	5.280	1.671	38.893
1618	5.817	5.290	1.672	39.264
1718	6.075	5.301	1.672	39.634
1818	6.333	5.314	1.673	40.000
19	3.298	5.541	1.678	34.978
19			2.581	14.393
619	3.407	5.538	1.677	35.156
719	3.646	5.532	1.676	35.542
819	3.887	5.528	1.675	35.926
919	4.130	5.525	1.674	36.307
1019	4.375	5.523	1.673	36.687
1119	4.622	5.523	1.672	37.064
1219	4.871	5.524	1.672	37.439
1319	5.121	5.527	1.672	37.812
1419	5.373	5.532	1.671	38.183
1519	5.626	5.538	1.671	38.551

$M_o^{\prime} = 4.1538$

P	x	y	M	θ°
917	3.678	4.408	1.961	37.416
1017	3.911	4.436	1.961	37.755
1117	4.145	4.465	1.961	38.090
1217	4.380	4.496	1.962	38.419
1317	4.615	4.528	1.963	38.744
18	3.140	4.585	1.960	36.185
18			3.024	15.269
18*	3.221	4.593	1.960	36.310
718	3.320	4.602	1.960	36.462
818	3.547	4.625	1.960	36.808
918	3.775	4.650	1.960	37.148
1018	4.006	4.676	1.960	37.483
1118	4.238	4.704	1.960	37.813
1218	4.471	4.733	1.961	38.139
19	3.324	4.837	1.959	36.061
19			3.030	15.057
719	3.422	4.846	1.959	36.212
819	3.647	4.868	1.959	36.554
919	3.874	4.891	1.959	36.890
1019	4.102	4.916	1.959	37.221
1119	4.332	4.942	1.959	37.547
20	3.548	5.140	1.957	35.922
20			3.038	14.804
20*	3.628	5.147	1.957	36.044
820	3.770	5.160	1.957	36.258
920	3.994	5.182	1.957	36.590
1020	4.219	5.205	1.958	36.916
21	3.732	5.389	1.956	35.812
21			3.044	14.595

TABLE VII

MACH NUMBER AND FLOW DIRECTION IN THE FIELDS AROUND DOUBLE-CONES

$M_o^! = 3.3694$ $\qquad$ $20^\circ - 40^\circ$ $\qquad$ $M_o^! = 4.1538$

P	x	y	M	θ°	P	x	y	M	θ°
1619	5.681	5.546	1.672	38.917					
1819	6.333	5.313	1.673	39.997					
20	3.520	5.880	1.678	34.807					
20			2.588	14.133					
20*	3.605	5.877	1.677	34.944					
720	3.755	5.873	1.677	35.185					
820	3.993	5.867	1.675	35.561					
920	4.233	5.862	1.674	35.936					
1020	4.475	5.859	1.674	36.307					
1120	4.719	5.857	1.673	36.677					
1220	4.965	5.857	1.672	37.045					
1320	5.213	5.859	1.672	37.411					
1420	5.462	5.862	1.672	37.775					
1520	5.712	5.866	1.672	38.136					
21	3.695	6.145	1.678	34.678					
21			2.593	13.930					
21*	3.780	6.142	1.677	34.815					
721	3.843	6.140	1.677	34.916					
821	4.079	6.133	1.676	35.287					
921	4.316	6.128	1.675	35.655					
1021	4.556	6.124	1.674	36.021					
1121	4.798	6.121	1.673	36.386					
1221	5.041	6.120	1.673	36.748					
1321	5.287	6.120	1.672	37.108					
1421	5.534	6.121	1.672	37.466					
22	3.870	6.410	1.678	34.557					
22			2.598	13.728					
22*	3.956	6.407	1.677	34.693					
722	3.933	6.407	1.677	34.656					
822	4.166	6.400	1.676	35.021					
922	4.401	6.393	1.675	35.384					
1122	4.878	6.384	1.674	36.104					
1222	5.119	6.381	1.673	36.461					
1322	5.362	6.380	1.673	36.816					
23	4.046	6.673	1.678	34.441					
23			2.603	13.528					
23*	4.131	6.670	1.677	34.574					
823	4.254	6.665	1.676	34.765					
923	4.487	6.658	1.675	35.123					
1023	4.722	6.651	1.675	35.479					
1123	4.959	6.646	1.674	35.833					
24	4.222	6.935	1.677	34.329					
24			2.609	13.329					
24*	4.307	6.932	1.677	34.462					
824	4.343	6.930	1.677	34.517					
924	4.574	6.922	1.676	34.870					
1024	4.807	6.915	1.675	35.221					
25	4.398	7.196	1.677	34.223					

TABLE VII

MACH NUMBER AND FLOW DIRECTION IN THE FIELDS AROUND DOUBLE-CONES

$M_o^1 = 3.3694$ $20^\circ - 40^\circ$ $M_o^1 = 4.1538$

P	x	y	M	θ°	P	x	y	M	θ°
25			2.615	13.130					
925	4.662	7.185	1.675	34.626					

TABLE VII

MACH NUMBER AND FLOW DIRECTION IN THE FIELDS AROUND DOUBLE-CONES

$25^\circ - 35^\circ$

$M'_0 = 2.0665$

P	X	y	M	θ°
101	.900	0.630	1.059	35.000
2	.277	1.677	1.079	31.895
2			1.469	22.077
2*	.566	1.467	1.079	32.749
102	.689	1.377	1.080	33.115
202	1.331	0.932	1.087	35.000
3	.404	2.327	1.093	30.855
3			1.473	21.159
3*	.695	2.121	1.093	31.623
103	.521	2.244	1.093	31.164
203	1.147	1.806	1.097	32.794
303	1.891	1.324	1.094	35.000
4	.567	3.054	1.108	29.813
4			1.479	20.243
4*	.861	2.851	1.109	30.485
204	1.006	2.750	1.110	30.817
304	1.703	2.290	1.105	32.672
404	2.528	1.770	1.101	35.000
5	.775	3.864	1.124	28.769
5			1.486	19.338
5*	1.071	3.664	1.126	29.367
205	.915	3.769	1.125	29.053
305	1.565	3.336	1.118	30.606
405	2.334	2.840	1.112	32.548
505	3.251	2.277	1.107	35.000
6	1.032	4.756	1.141	27.761
6			1.494	18.455
6*	1.330	4.560	1.136	28.439
306	1.486	4.456	1.134	28.795
406	2.200	3.991	1.126	30.411
506	3.051	3.453	1.118	32.442
606	4.063	2.845	1.112	35.000
7	1.328	5.701	1.152	26.957
7			1.503	17.621
7*	1.626	5.505	1.147	27.586
307	1.472	5.606	1.149	27.261
407	2.136	5.171	1.141	28.623
507	2.926	4.665	1.132	30.319
607	3.866	4.083	1.123	32.444
707	4.934	3.455	1.118	35.000
8	1.661	6.688	1.162	26.224
8			1.513	16.839
8*	1.960	6.493	1.158	26.780
408	2.139	6.376	1.156	27.112
508	2.874	5.903	1.146	28.548
608	3.747	5.353	1.136	30.328
708	4.741	4.749	1.128	32.461

$M'_0 = 2.3604$

P	X	y	M	θ°
101	.600	0.420	1.313	35.000
2	.311	0.950	1.310	33.515
2			1.669	23.383
2*	.443	0.912	1.313	33.745
102	.641	0.854	1.317	34.089
202	1.057	0.740	1.320	35.000
3	.516	1.534	1.318	32.530
3			1.672	22.525
3*	.647	1.495	1.321	32.744
103	.712	1.475	1.322	32.849
203	1.119	1.356	1.323	33.694
303	1.705	1.194	1.323	35.000
4	.737	2.130	1.327	31.630
4			1.675	21.738
4*	.868	2.089	1.329	31.829
104	.801	2.110	1.328	31.727
204	1.199	1.987	1.328	32.512
304	1.770	1.819	1.326	33.726
404	2.366	1.657	1.325	35.000
5	.975	2.736	1.335	30.804
5			1.680	21.012
5*	1.106	2.694	1.335	31.062
205	1.297	2.633	1.334	31.438
305	1.852	2.462	1.330	32.567
405	2.433	2.293	1.328	33.754
505	3.041	2.129	1.328	35.000
6	1.226	3.349	1.341	30.117
6			1.685	20.342
6*	1.356	3.306	1.340	30.364
206	1.412	3.288	1.340	30.469
306	1.952	3.114	1.336	31.520
406	2.517	2.942	1.332	32.626
506	3.110	2.772	1.330	33.790
606	3.725	2.608	1.330	35.000
7	1.489	3.966	1.347	29.491
7			1.691	19.722
7*	1.620	3.923	1.346	29.728
207	1.543	3.948	1.347	29.589
307	2.068	3.774	1.342	30.571
407	2.618	3.600	1.338	31.604
507	3.196	3.425	1.334	32.691
607	3.795	3.255	1.333	33.824
707	4.415	3.091	1.332	35.000
8	1.765	4.588	1.353	28.918
8			1.697	19.146
8*	1.895	4.544	1.352	29.154
308	2.201	4.441	1.348	29.709

TABLE VII

MACH NUMBER AND FLOW DIRECTION IN THE FIELDS AROUND DOUBLE-CONES

$25^\circ - 35^\circ$

$M_o^! = 2.0565$

P	x	y	M	θ°
808	5.860	4.103	1.122	35.000
9	2.036	7.720	1.174	25.523
9			1.523	16.102
9*	2.335	7.526	1.170	26.039
409	2.204	7.611	1.171	25.812
509	2.890	7.169	1.161	27.043
609	3.703	6.653	1.151	28.554
709	4.627	6.080	1.141	30.347
809	5.669	5.456	1.132	32.473
909	6.842	4.791	1.126	35.000
10	2.451	8.793	1.185	24.881
10			1.534	15.403
10*	2.751	8.600	1.130	25.386
510	2.969	8.460	1.176	25.753
610	3.728	7.977	1.165	27.353
710	4.589	7.438	1.154	28.578
810	5.559	6.845	1.144	30.371
910	6.653	6.199	1.135	32.496
1010	7.876	5.515	1.129	35.000
11	2.902	9.899	1.194	24.318
11			1.546	14.740
11*	3.203	9.707	1.189	24.795
511	3.107	9.768	1.191	24.642
611	3.818	9.316	1.180	25.775
711	4.622	8.810	1.169	27.092
811	5.527	8.250	1.157	28.624
911	6.547	7.634	1.147	30.424
1011	7.689	6.967	1.138	32.540
1111	8.952	6.268	1.132	35.000
12	3.389	11.031	1.203	23.810
12			1.558	14.108
12*	3.690	10.839	1.198	24.262
612	3.966	10.664	1.194	24.676
712	4.720	10.188	1.182	25.828
812	5.567	9.661	1.171	27.156
912	6.519	9.077	1.159	28.701
1012	7.585	8.439	1.149	30.503
1112	8.768	7.756	1.140	32.594
1212	.064	7.047	1.134	35.000
13	3.906	12.183	1.211	23.350
13			1.571	13.501
613	4.166	12.018	1.207	23.722
713	4.876	11.571	1.196	24.744
813	5.670	11.074	1.184	25.910
913	6.562	10.523	1.172	27.255
1013	7.559	9.917	1.161	28.808
1213	.069	7.005	1.133	34.910
14	4.383	13.205	1.218	22.986

$M_o^! = 2.3604$

P	x	y	M	θ°
408	2.736	4.265	1.343	30.676
508	3.298	4.089	1.339	31.693
608	3.883	3.914	1.336	32.754
708	4.488	3.744	1.334	33.856
808	5.113	3.580	1.334	35.000
9	2.051	5.214	1.359	28.401
9			1.703	18.608
9*	2.181	5.169	1.357	28.630
309	2.348	5.112	1.355	28.924
409	2.869	4.936	1.350	29.831
509	3.416	4.759	1.345	30.785
609	3.986	4.532	1.341	31.780
709	4.576	4.407	1.338	32.815
809	5.187	4.237	1.336	33.889
909	5.818	4.073	1.336	35.000
10	2.348	5.842	1.364	27.928
10			1.709	18.104
310	2.510	5.785	1.362	28.206
410	3.017	5.610	1.356	29.059
510	3.549	5.433	1.351	29.957
610	4.104	5.254	1.346	30.891
710	4.680	5.077	1.342	31.864
810	5.277	4.903	1.339	32.875
910	5.893	4.733	1.338	33.921
1010	6.526	4.570	1.337	35.000
11	2.726	6.615	1.371	27.400
11			1.717	17.527
11*	2.856	6.570	1.369	27.611
411	3.215	6.443	1.364	28.196
511	3.731	6.266	1.358	29.030
611	4.268	6.087	1.353	29.899
711	4.826	5.908	1.348	30.803
811	5.405	5.730	1.344	31.742
911	6.004	5.555	1.341	32.714
1011	6.620	5.384	1.340	33.719
1111	7.400	5.182	1.338	35.000
12	3.043	7.246	1.376	27.005
12			1.724	17.085
12*	3.172	7.200	1.374	27.210
412	3.393	7.121	1.371	27.560
512	3.895	6.946	1.364	28.349
612	4.418	6.768	1.359	29.170
712	4.962	6.589	1.353	30.024
812	5.527	6.409	1.349	30.910
912	6.112	6.231	1.345	31.828
1012	6.715	6.056	1.343	32.777
1112	7.478	5.847	1.340	33.988
1212	8.117	5.684	1.340	35.000
13	3.368	7.877	1.381	26.641

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TABLE VII

MACH NUMBER AND FLOW DIRECTION IN THE FIELDS AROUND DOUBLE-CONES

$M_o^1 = 2.0665$ $25^o - 35^o$

P	X	y	M	θ^o
14			1.582	12.987
714	5.056	12.780	1.206	23.914
814	5.810	12.308	1.195	24.957

$M_o^1 = 2.3604$

P	X	y	M	θ^o
13			1.731	16.665
13*	3.497	7.831	1.379	26.841
413	3.582	7.800	1.377	26.974
513	4.071	7.626	1.371	27.722
613	4.581	7.449	1.365	28.500
713	5.111	7.271	1.359	29.308
813	5.663	7.091	1.354	30.146
913	6.234	6.911	1.350	31.014
1013	6.823	6.733	1.346	31.912
1113	7.569	6.519	1.343	33.057
1213	8.196	6.350	1.341	34.016
1313	8.837	6.188	1.341	35.000
14	3.700	8.508	1.385	26.306
14			1.738	16.265
14*	3.829	8.461	1.383	26.502
414	3.783	8.478	1.384	26.432
514	4.259	8.306	1.377	27.144
614	4.756	8.131	1.371	27.882
714	5.273	7.953	1.365	28.649
814	5.811	7.773	1.359	29.443
914	6.369	7.593	1.354	30.266
1014	6.944	7.413	1.350	31.117
1114	7.674	7.195	1.346	32.202
1214	8.288	7.022	1.344	33.111
1314	8.916	6.853	1.342	34.045
1414	9.557	6.692	1.342	35.000
15	4.038	9.138	1.390	25.997
15			1.745	15.882
15*	4.167	9.091	1.388	26.185
515	4.457	8.985	1.383	26.609
615	4.941	8.812	1.376	27.312
715	5.446	8.635	1.370	28.041
815	5.971	8.456	1.364	28.796
915	6.516	8.276	1.359	29.577
1015	7.078	8.095	1.355	30.385
1115	7.791	7.875	1.350	31.415
1215	8.392	7.698	1.347	32.278
1415	9.556	6.682	1.342	34.982
16	4.383	9.766	1.394	25.708
16			1.752	15.514
16*	4.512	9.718	1.392	25.893
516	4.665	9.662	1.389	26.114
616	5.138	9.491	1.382	26.784
716	5.629	9.316	1.376	27.479
816	6.142	9.138	1.370	28.199
916	6.674	8.958	1.364	28.942
1016	7.223	8.778	1.359	29.710
1116	7.921	8.556	1.354	30.689
17	4.733	10.392	1.398	25.442
17			1.759	15.160

TABLE VII

MACH NUMBER AND FLOW DIRECTION IN THE FIELDS AROUND DOUBLE-CONES

$M_o' = 2.0665$ | $25^\circ - 35^\circ$ | $M_o' = 2.3604$

P	x	y	M	θ°

P	x	y	M	θ°
517	4.882	10.336	1.395	25.653
617	5.343	10.168	1.388	26.295
717	5.823	9.995	1.382	26.959
817	6.323	9.819	1.375	27.645
917	6.843	9.640	1.369	28.354
1017	7.380	9.459	1.364	29.086
18	5.141	11.107	1.402	25.161
18			1.767	14.768
18*	5.270	11.059	1.400	25.337
618	5.589	10.941	1.395	25.773
718	6.055	10.771	1.388	26.404
818	6.542	10.597	1.381	27.057
918	7.048	10.419	1.375	27.730
19	5.501	11.726	1.406	24.934
19			1.775	14.438
719	6.267	11.441	1.393	25.957

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TABLE VII

MACH NUMBER AND FLOW DIRECTION IN THE FIELDS AROUND DOUBLE-CONES

$25^{\circ}-35^{\circ}$

$M_o^{\prime} = 2.7296$

P	x	y	M	θ°
101	.600	0.420	1.547	35.000
2	.419	0.908	1.541	33.731
2			1.903	23.562
2*	.539	0.894	1.544	33.926
102	.719	0.873	1.549	34.130
202	1.177	0.824	1.550	35.000
3	.715	1.522	1.548	32.835
3			1.906	22.723
3*	.835	1.506	1.551	32.961
103	.894	1.499	1.552	33.023
203	1.341	1.443	1.552	33.840
303	1.963	1.375	1.551	35.000
4	1.028	2.142	1.556	31.971
4			1.910	21.961
4*	1.148	2.125	1.558	32.089
104	1.087	2.134	1.557	32.029
204	1.522	2.073	1.555	32.797
304	2.128	1.996	1.552	33.889
404	2.754	1.928	1.552	35.000
5	1.357	2.768	1.564	31.186
5			1.916	21.265
5*	1.477	2.750	1.563	31.406
205	1.720	2.714	1.560	31.854
305	2.310	2.631	1.556	32.883
405	2.920	2.554	1.553	33.932
505	3.551	2.487	1.553	35.000
6	1.696	3.395	1.568	30.580
6			1.921	20.627
6*	1.816	3.376	1.567	30.795
206	1.932	3.357	1.565	31.005
306	2.507	3.269	1.560	31.978
406	3.102	3.187	1.556	32.970
506	3.717	3.111	1.554	33.980
506	4.348	3.044	1.554	35.000
7	2.045	4.021	1.573	30.037
7			1.927	20.041
207	2.158	4.002	1.571	30.236
307	2.717	3.910	1.565	31.159
407	3.297	3.823	1.560	32.099
507	3.898	3.741	1.557	33.057
607	4.514	3.667	1.555	34.024
707	5.142	3.601	1.554	35.000
8	2.384	4.616	1.577	29.569
8			1.934	19.523
8*	2.503	4.595	1.575	29.762
308	2.929	4.521	1.570	30.448
408	3.495	4.431	1.565	31.343

$M_o^{\prime} = 3.2188$

P	x	y	M	θ°
101	.600	0.420	1.803	35.000
2	.396	0.695	1.795	34.199
2			2.180	23.951
2*	.499	0.696	1.798	34.299
102	.708	0.697	1.803	34.500
202	1.001	0.701	1.803	35.000
3	.719	1.241	1.800	33.402
3			2.182	23.221
3*	.822	1.241	1.802	33.496
103	.926	1.240	1.805	33.591
203	1.212	1.240	1.804	34.067
303	1.777	1.244	1.803	35.000
4	1.053	1.790	1.806	32.680
4			2.186	22.556
104	1.156	1.789	1.808	32.769
204	1.435	1.785	1.806	33.224
304	1.986	1.781	1.804	34.114
404	2.549	1.785	1.803	35.000
5	1.398	2.342	1.812	32.020
5			2.191	21.946
5*	1.501	2.339	1.811	32.185
205	1.670	2.335	1.810	32.455
305	2.208	2.325	1.806	33.307
405	2.759	2.321	1.804	34.155
505	3.322	2.326	1.803	35.000
6	1.750	2.891	1.815	31.499
6			2.196	21.385
6*	1.853	2.888	1.814	31.660
206	1.915	2.885	1.813	31.758
306	2.440	2.870	1.809	32.575
406	2.978	2.861	1.805	33.388
505	3.530	2.858	1.803	34.198
606	4.089	2.863	1.803	35.000
7	2.108	3.438	1.818	31.027
7			2.202	20.866
7*	2.211	3.434	1.817	31.186
207	2.169	3.436	1.818	31.122
307	2.682	3.415	1.812	31.906
407	3.207	3.401	1.808	32.687
507	3.747	3.392	1.805	33.466
607	4.295	3.391	1.803	34.236
707	4.850	3.396	1.803	35.000
8	2.472	3.983	1.822	30.600
8			2.208	20.383
8*	2.574	3.978	1.820	30.755
308	2.931	3.961	1.816	31.294
408	3.445	3.942	1.811	32.045

TABLE VII

MACH NUMBER AND FLOW DIRECTION IN THE FIELDS AROUND DOUBLE-CONES

$M_o^! = 2.7296$ $25^\circ - 35^\circ$ $M_o^! = 3.2188$

$M_o^! = 2.7296$

P	x	y	M	θ°
508	4.082	4.344	1.560	32.256
608	4.684	4.264	1.557	33.178
708	5.300	4.191	1.556	34.108
808	5.897	4.129	1.555	35.000
9	2.748	5.238	1.581	29.112
9			1.940	19.016
9*	2.867	5.217	1.580	29.300
309	3.163	5.164	1.576	29.767
409	3.714	5.071	1.569	30.620
509	4.287	4.980	1.564	31.488
609	4.876	4.895	1.561	32.366
709	5.478	4.816	1.558	33.252
809	6.062	4.748	1.556	34.102
909	6.688	4.683	1.556	35.000
10	3.119	5.859	1.585	28.696
10			1.947	18.542
10*	3.238	5.837	1.584	28.881
310	3.407	5.806	1.581	29.143
410	3.944	5.710	1.575	29.957
510	4.504	5.617	1.569	30.786
610	5.079	5.528	1.564	31.623
710	5.668	5.444	1.561	32.468
810	6.240	5.370	1.558	33.280
910	6.853	5.299	1.557	34.137
1010	7.477	5.235	1.557	35.000
11	3.496	6.477	1.590	28.318
11			1.954	18.096
11*	3.615	6.454	1.588	28.500
311	3.660	6.446	1.587	28.570
411	4.185	6.349	1.580	29.348
511	4.731	6.253	1.574	30.141
611	5.293	6.161	1.569	30.941
711	5.868	6.073	1.564	31.749
811	6.429	5.995	1.561	32.525
911	7.030	5.918	1.559	33.345
1011	7.641	5.847	1.558	34.170
1111	8.261	5.785	1.557	35.000
12	3.878	7.091	1.594	27.974
12			1.962	17.674
12*	3.997	7.068	1.592	26.153
312	3.923	7.083	1.593	28.041
412	4.434	6.985	1.585	28.788
512	4.967	6.888	1.579	29.548
612	5.516	6.793	1.573	30.314
712	6.079	6.703	1.568	31.088
812	6.627	6.620	1.564	31.830
912	7.216	6.539	1.561	32.616
1012	7.816	6.463	1.559	33.407
1112	8.425	6.393	1.558	34.202
13	4.265	7.702	1.597	27.660

$M_o^! = 3.2188$

P	x	y	M	θ°
508	3.973	3.928	1.807	32.794
608	4.510	3.921	1.805	33.536
708	5.055	3.920	1.803	34.271
808	5.606	3.926	1.803	35.000
9	2.840	4.524	1.825	30.210
9			2.214	19.930
9*	2.943	4.519	1.824	30.364
309	3.189	4.506	1.820	30.730
409	3.691	4.483	1.815	31.455
509	4.208	4.465	1.810	32.177
609	4.734	4.453	1.807	32.892
709	5.268	4.446	1.805	33.601
809	5.809	4.446	1.803	34.304
909	6.358	4.452	1.803	35.000
10	3.212	5.062	1.828	29.855
10			2.221	19.505
10*	3.315	5.056	1.827	30.007
310	3.453	5.048	1.825	30.210
410	3.944	5.022	1.819	30.909
510	4.450	5.001	1.814	31.607
610	4.965	4.984	1.810	32.297
710	5.489	4.973	1.807	32.982
810	6.020	4.967	1.805	33.661
910	6.559	4.967	1.803	34.333
1010	7.102	4.973	1.803	35.000
11	3.588	5.597	1.831	29.531
11			2.228	19.102
311	3.723	5.588	1.829	29.728
411	4.203	5.560	1.823	30.405
511	4.698	5.535	1.817	31.080
611	5.203	5.514	1.813	31.747
711	5.716	5.499	1.809	32.409
811	6.238	5.488	1.806	33.065
911	6.767	5.483	1.804	33.716
1011	7.302	5.484	1.803	34.361
1111	7.841	5.490	1.803	35.000
12	4.076	6.279	1.835	29.156
12			2.237	18.614
12*	4.179	6.272	1.833	29.299
412	4.543	6.247	1.828	29.806
512	5.024	6.219	1.822	30.454
612	5.516	6.194	1.817	31.095
712	6.017	6.174	1.812	31.730
812	6.527	6.159	1.809	32.360
912	7.044	6.148	1.807	32.984
1112	7.839	5.484	1.803	34.990
13	4.458	6.803	1.838	28.887
13			2.244	18.254
13*	4.560	6.796	1.836	29.029

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TABLE VII

MACH NUMBER AND FLOW DIRECTION IN THE FIELDS AROUND DOUBLE-CONES

$M_o' = 2.7296$ 25°– 35° $M_o' = 3.2188$

$M_o' = 2.7296$

P	x	y	M	θ°
13			1.969	17.272
13*	4.384	7.679	1.595	27.830
413	4.691	7.618	1.591	28.271
513	5.211	7.520	1.584	29.001
613	5.748	7.424	1.578	29.736
713	6.299	7.331	1.572	30.478
813	6.836	7.246	1.568	31.191
913	7.413	7.160	1.564	31.944
14	4.656	8.309	1.601	27.367
14			1.977	16.889
14*	4.774	8.285	1.599	27.535
414	4.956	8.249	1.596	27.792
514	5.464	8.150	1.589	28.494
614	5.988	8.053	1.582	29.202
714	6.527	7.958	1.577	29.915
814	7.053	7.870	1.572	30.600
15	5.050	8.911	1.604	27.098
15			1.984	16.520
15*	5.168	8.887	1.602	27.265
415	5.227	8.875	1.601	27.347
515	5.723	8.776	1.594	28.024
615	6.236	8.678	1.587	28.706
715	6.763	8.581	1.581	29.393
16	5.446	9.508	1.608	26.853
16			1.992	16.166
516	5.988	9.397	1.599	27.586

$M_o' = 3.2188$

P	x	y	M	θ°
413	4.814	6.778	1.832	29.380
513	5.285	6.747	1.826	30.008
613	5.767	6.720	1.820	30.630
713	6.259	6.697	1.815	31.246
14	4.840	7.324	1.840	28.640
14			2.252	17.908
14*	4.943	7.316	1.839	28.781
414	5.089	7.305	1.836	28.981
514	5.550	7.273	1.830	29.592
614	6.023	7.243	1.824	30.196
15	5.224	7.839	1.843	28.413
15			2.259	17.572
515	5.818	7.793	1.833	29.202

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